C Programming Basic (week 1)

For HEDSPI Project

Lecturers :

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Introduction

- C Programming practice in UNIX environment.
- Programming topics related to [Data Structures and Algorithms]
- Compiler: gcc
- Editor: Emacs, K-Developper.

gcc syntax

- Parameter:
  - -Wall : turn on all alerts
  - -c: make object file
  - -o: name of output file
  - -g: debug information
  - -l: library

```
gcc –Wall hello.c –o runhello
./runhello
```

This week: Basic Data Structures and Algorithms

- Topic:
  - Array, String, Pointer Review
  - Character based File operations in UNIX
  - Programming Exercises

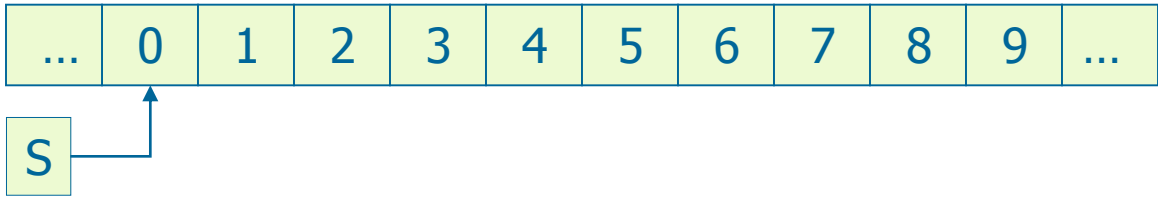
Array

- A block of many variables of the same type
- Array can be declared for any type
  - E.g. `int A[10]` is an array of 10 integers.
- Examples:
  - list of students' marks
  - series of numbers entered by user
  - vectors
  - matrices

Arrays in Memory

- Sequence of variables of specified type
- The array variable itself holds the address in memory of beginning of sequence
- Example:

```
double S[10];
```



- The k-th element of array A is specified by A[k-1] **(0-based)**

Example - reverse

```
#include <stdio.h>

int main(void)
{
   int i, A[10];

   printf("please enter 10 numbers:\n");
   for(i=0; i<10; i++)
      scanf("%d", &A[i]);

   printf("numbers in reversed order:\n");
   for(i=9; i>=0; i--)
      printf("%d\n", A[i]);

   return 0;
}
```

Exercise

- Write a program that gets an input line from the user (ends with '\n') and displays the number of times each letter appears in it.

The output for the input line: "hello, world!"

The letter 'd' appears 1 time(s).
The letter 'e' appears 1 time(s).
The letter 'h' appears 1 time(s).
The letter 'l' appears 3 time(s).
The letter 'o' appears 2 time(s).
The letter 'r' appears 1 time(s).
The letter 'w' appears 1 time(s).

Assume all inputs are lower-case!

Solution

```
#define ALPHABET_LEN 26

int main(void)
{
     int i = 0,
    count[ALPHABET_LEN] = {0};
    char c = '\0';

    printf("Please enter a line of text: \n");

    /* Read in letter by letter and update the count array
    */
      c = getchar();
    while (c != '\n'  &&  c >= 0)
    {
        if (c <= 'z'  &&  c >= 'a')
         ++count[c - 'a'];
        if (c <= 'Z'  &&  c >= 'A')
         ++count[c - 'A'];
        c = getchar();
    }
```

Solution

```
for (i = 0; i < ABC_LEN; ++i)    {
    if (count[i] > 0)

    printf("The letter '%c' appears %d time(s).\n", 'a' + i,
    count[i]);

}

return 0;

}
```

Exercise (20 minutes)

- Implement a function that accepts two integer arrays and returns 1 if they are equal, 0 otherwise
- Write a program that accepts two arrays of integers from the user and checks for equality

Solution

```
#include <stdio.h>

#define SIZE 5

int compare_arrays(int arr1[], int arr2[], int size)
{
   int i = 0;

   for (i = 0; i < size; ++i)
   {
       if (arr1[i] != arr2[i])
           return 0;
   }

     /* if we got here, both arrays are identical */
     return 1;
}
```

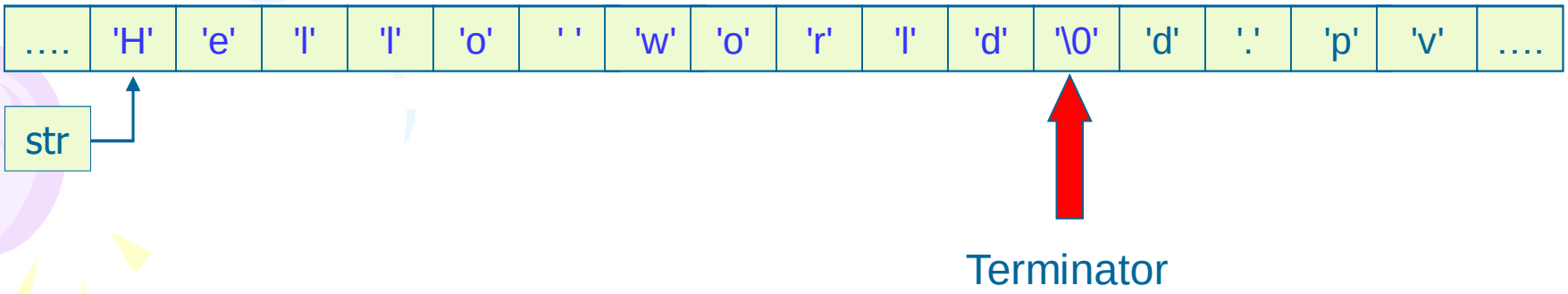
Solution

```
int main(void)
{
   int input1[SIZE], input2[SIZE], i;

   printf("Please enter a list of %d integers:\n",
   SIZE);
   for (i = 0; i < SIZE; ++i)  scanf("%d", &input1[i]);

   printf("Please enter another list of %d
   integers:\n", SIZE);
   for (i = 0; i < SIZE; ++i) scanf("%d", &input2[i]);

   if (compare_arrays(input1, input2, SIZE) == 1)
      printf("Both lists are identical!\n");
   else
      printf("The lists are not identical...\n");

   return 0;
}
```

Strings

- An array of characters
- Used to store text
- Another way to initialize:

```
char str[] = "Text";
```



String

- In order to hold a string of N characters we need an array of length N + 1
- So the previous initialization is equivalent to

```
char str[] = {'b', 'l', 'a', 'b', 'l',
'a', '\0'};
```

String and character related function

- getchar()
  - c = getchar()
- scanf
  - scanf("%s", str);
- gets()
  - gets(str);

String and character related function

- **`strlen(const char s[])`**
  returns the length of s
- **`strcmp(const char s1[],`**
  `const char s2[])`
  compares s1 with s2
- **`strcpy(char s1[],`**
  `const char s2[])`
  copies to contents of s2 to s1

Exercise

- write a function that:
  - gets a string and two chars
  - the functions scans the string and replaces every occurrence of the first char with the second one.
- write a program to test the above function
  - the program should read a string from the user (no spaces) and two characters, then call the function with the input, and print the result.
- example
  - input: “papa”, ‘p’, ‘m’
  - output: “mama”

Solution

```
void replace(char str[], char replace_what,
                         char replace_with)
{
    int i;

    for (i = 0; str[i] != '\0'; ++i)
    {
        if (str[i] == replace_what)
            str[i] = replace_with;
    }
}
```

Solution

```
#define STRING_LEN 100

int main(void)
{
    char str[STRING_LEN + 1];
    char replace_what, replace_with, tmp;

    printf("Please enter a string (no spaces)\n");
    scanf("%100s", str);

    printf("Letter to replace: ");
    scanf(" %c", &replace_what);
     do {tmp=getchar();} while (tmp!='\n');

    printf("Letter to replace with: ");
    scanf(" %c", &replace_with);

    replace(str, replace_what, replace_with);
    printf("The result: %s\n", str);
    return 0;
}
```

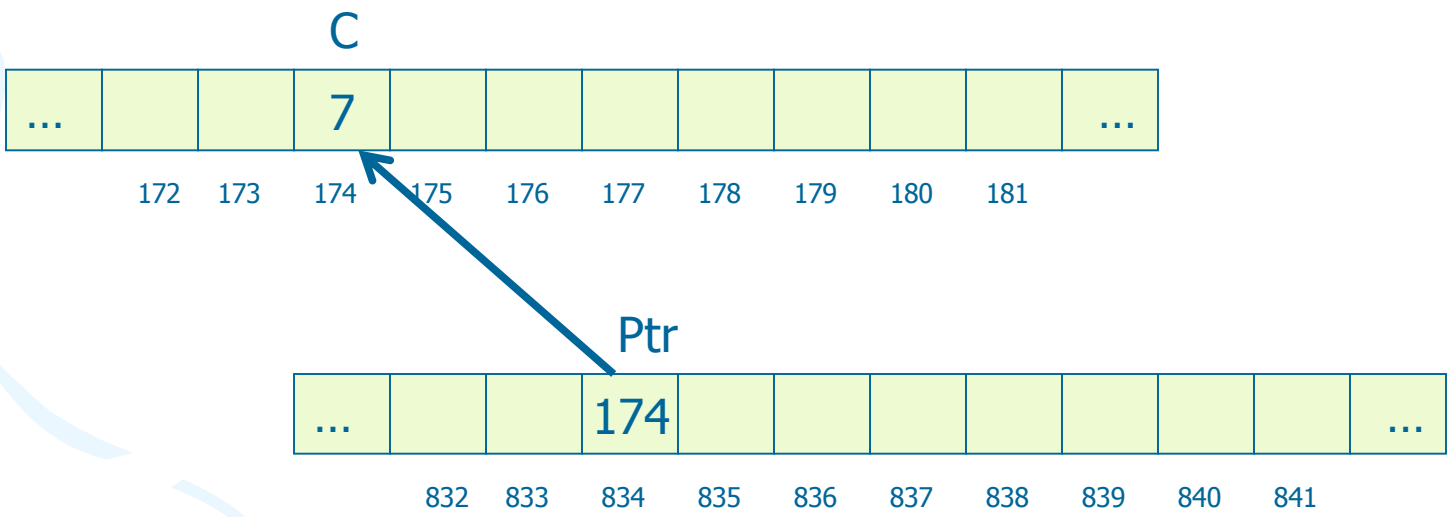
Pointer - Declaration

```
type *variable_name;
```

- A pointer is declared by adding a * before the variable name.
- Pointer is a variable that contains an address in memory.
- The address should be the address of a variable or an array that we defined.

Pointers

- Here ptr is said to *point* to the address of variable c



Referencing and Dereferencing

```
int n;
int *iptr; /* Declare P as a pointer to int */
n = 7;
iptr = &n;

printf("%d", *iptr); /* Prints out '7'*/
*iptr = 177;
printf("%d", n); /* Prints out '177' */
iptr = 177; /* This is unadvisable!! */
```

Exercises

Write a function that accepts a double parameter and returns its integer and fraction parts.

Write a program that accepts a number from the user and prints out its integer and fraction parts, using this function.

Solution

```
void split(double num, int *int_part, double *frac_part)
{
    *int_part = (int)num;
    *frac_part = num - *int_part;
}

int main(void)
{
    double num, fraction;
    int integer;

    printf("Please enter a real number: ");
    scanf("%f", &num);

    split(num, &integer, &fraction);
    printf("The integer part is %d\n", integer);
    printf("The remaining fraction is %f\n", fraction);

    return 0;
}
```

Exercise

- Write a function with the prototype:

```
void replace_char(char *str,
                  char c1,
                  char c2);
```

- It replaces each appearance of `c1` by `c2` in the string `str`.
  Do not use the `[]` operator!
- Demonstrate your function with a program that uses it

Solution

```
void replace_char(char *str, char c1, char c2)
{
    if (str == NULL)
        return;

    while (*str != '\0')
    {
        if (*str == c1)
            *str = c2;

        ++str;
    }
}
```

Command line arguments

- Command line arguments are arguments for the **`main`** function
  - Recall that main is basically a function
  - It can receive arguments like other functions
  - The ‘calling function’ in this case is the operating system, or another program

‘main’ prototype

```
int main(int argc, char* argv[])
```

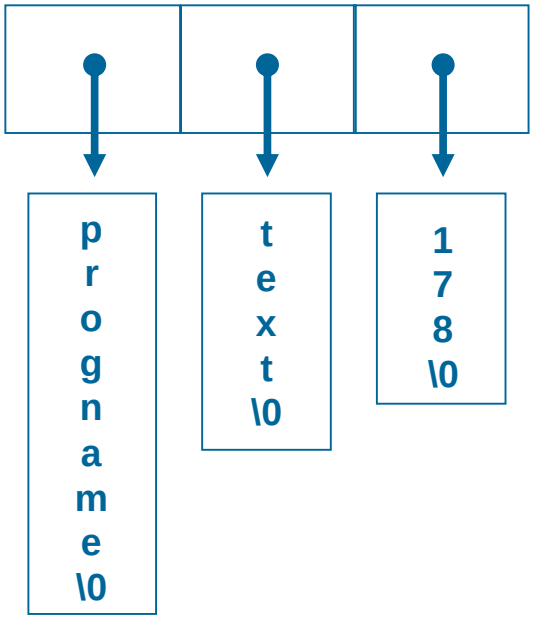
- When we want **`main`** to accept command line arguments, we must define it like this
  - **`argc`** holds the number of arguments that were entered by the caller
  - **`argv`** is an array of pointers to char – an array of strings – holding the text values of the arguments
- The first argument is always the program’s name

‘main’ prototype

```
int main(int argc, char* argv[])
```

argc : 3

argv :



Exercise

- Write a program that accepts two numbers as command line arguments, representing a rectangle's height and width (as floating-point numbers).
- The program should display the rectangle's area and perimeter

Solution

```
int main(int argc, char* argv[])
{
    double width, height;

    if (argc != 3)
    {
        printf("Wrong number of arguments!\n");
        return 1;
    }

    width = atof(argv[1]);
    height = atof(argv[2]);

    printf("The rectangle's area is %f\n", width * height);
    printf("The rectangle's perimeter is %f\n",
              2 * (width + height));

    return 0;
}
```

File Handling

- **C communicates with files using a new datatype called a file pointer.**

- **File pointer:**
  - **references a disk file.**
  - **used by a stream to conduct the operation of the I/O functions.**

- **FILE *fptr;**

4 major operations

- Open the file
- Read from a file → program
- Write to a file: Program → file
- Close the file.

Opening a file

- fopen() function.
- FILE *fopen(const char *filename, const char *mode);

```
FILE *fptr;
if ((fptr = fopen("test.txt", "r")) ==
  NULL){
    printf("Cannot open test.txt file.\n");
    exit(1);
}
```

Opening a file

- filename: name of the file.
  - It can be a string literal: **"data.txt"**
  - It may contain the full path of the file: **"/root/hedspi/CProgrammingBasic/Lab1/data.txt"**
  - It may be a character array that contains the file name:

```
char file_name[] = "junk.txt";
```

- ***NOTE:*** *If the file path is not specified, the file is located in the same folder as the C program.*

Mode for text file

mode	Description
"r"	opens an existing text file for reading.
"w"	creates a text file for writing.
"a"	opens an existing text file for appending.
"r+"	opens an existing text file for reading or writing.
"w+"	creates a text file for reading or writing.
"a+"	opens or create an existing text file for appending.

Mode for binary file

mode	Description
"rb"	opens an existing binary file for reading.
"wb"	creates a binary file for writing.
"ab"	opens an existing binary file for appending.
"r+b"	opens an existing binary file for reading or writing.
"w+b"	creates a binary file for reading or writing.
"a+b"	opens or create an existing binary file for appending.

Closing a file

- The fclose command can be used to disconnect a file pointer from a file.

- int fclose(FILE *stream);

Example: File Open and Close

```
1:  /* Opening and closing a file */
2:  #include <stdio.h>
3:
4:  enum {SUCCESS, FAIL};
5:
6:  main(void)
7:  {
8:     FILE *fptr;
9:     char filename[]= "haiku.txt";
10:    int reval = SUCCESS;
11:
12:    if ((fptr = fopen(filename, "r")) == NULL){
13:       printf("Cannot open %s.\n", filename);
14:       reval = FAIL;
15:    } else {
16:       printf("The value of fptr: 0x%p\n", fptr);
17:       printf("Ready to close the file.");
18:       fclose(fptr);
19:    }
20:
21:    return reval;
22: }
```

Reading and Writing Disk Files

- In C, you can perform I/O operations in the following ways:
  - **Read or write one character at a time.**
  - **Read or write one line of text (that is, one character line) at a time.**
  - Read or write one block of characters at a time.

Character based file operations in UNIX

- **Read or write one character at a time.**
- Character input and output
  - fgetc() and fputc()
- int fgetc(FILE *stream);
- int fputc(int c , FILE *stream);

Exercise F1

- Create a text file name lab1.txt with the content as you want.
- Write a program to read from a text file one character at a time, then write it to a new file with the name lab1w.txt

Solution

```
#include <stdio.h>
enum {SUCCESS, FAIL};

void CharReadWrite(FILE *fin, FILE *fout)
{
   int c;
   while ((c=fgetc(fin)) != EOF){
   fputc(c, fout);  /* write to a file */
   putchar(c);
   /* display character on the screen */
   }
}
```

Solution

enum {SUCCESS, FAIL};

```
main(void) {
   FILE *fptr1, *fptr2;
   char filename1[]= "lab1a.txt";
   char filename2[]= "lab1.txt";
   int reval = SUCCESS;

   if ((fptr1 = fopen(filename1, "w")) == NULL){
        printf("Cannot open %s.\n", filename1);
        reval = FAIL;
   } else if ((fptr2 = fopen(filename2, "r")) == NULL){
   printf("Cannot open %s.\n", filename2);
   reval = FAIL;
   } else {
       CharReadWrite(fptr2, fptr1);
       fclose(fptr1);
       fclose(fptr2);
   }
   return reval;
}
```

Exercise (cont)

- Write a program to read sentences from a specified file one character at a time.
- Each capital letter is converted into a lower-case letter, and each lower-case letter is converted into a capital letter. The new sentence is then written into another file.
- Note that you must output numbers, the signs as they are.

Solution

- Just modify the function CharReadWrite and character manipulate functions in <ctype.h>

```
void CharReadWrite(FILE *fin, FILE *fout)
{
   int c;
   while ((c=fgetc(fin)) != EOF){
   if islower(c) c=toupper(c);
   if isupper(c) c=tolower(c);
   fputc(c, fout);  /* write to a file */
   putchar(c);
   /* display character on the screen */
   }
}
```

Read or write one line at a time.

- Two functions: fgets() and fputs()
- char *fgets(char *s, int n, FILE *stream);
  - s references an array that is used to store characters
  - n specifies the maximum number of array elements.
- fgets() function can read up to n-1 characters, and can append a null character after the last character fetched, until a newline or an EOF is encountered.

Read or write one line at a time.

- int fputs(const char *s, FILE *stream);
- s: array that contains the characters to be written to a file
- return value
  - 0 for success
  - non zero in case of fail.

Exercise

- Redo the exercise F1 but the program will read and write one character line at a time.

Solution

```
#include <stdio.h>
enum {SUCCESS, FAIL, MAX_LEN = 81 };

void LineReadWrite(FILE *fin, FILE
  *fout)
{
  char buff[MAX_LEN];
  while (fgets(buff, MAX_LEN, fin) !=
  NULL) {
   fputs(buff, fout);
   printf("%s", buff);
  }
}
```

Solution

```
main(void) {
   FILE *fptr1, *fptr2;
   char filename1[]= "lab1a.txt";
   char filename2[]= "lab1.txt";
   int reval = SUCCESS;

   if ((fptr1 = fopen(filename1, "w")) == NULL){
        printf("Cannot open %s.\n", filename1);
        reval = FAIL;
   } else if ((fptr2 = fopen(filename2, "r")) == NULL){
   printf("Cannot open %s.\n", filename2);
   reval = FAIL;
   } else {
      LineReadWrite(fptr2, fptr1);
      fclose(fptr1);
      fclose(fptr2);
   }
   return reval;
}
```

Read and write formated text

- int fscanf(FILE *stream, const char *format, ...);
  - This function works like scanf except that it read from a file stream.
- int fprintf(FILE *stream, const char *format, ...);
  - The only difference between fprintf and printf is that fprintf can redirect output to a particular stream.

Exercise

Write a program to read two or more lines into an array of character strings one by one from a specified file and find the length of each line. You must write the length of each line and character string in the file.

For example, one line in an input file

The quick brown fox jumps over the lazy dog.

should be output as follows.

44 The quick brown fox jumps over the lazy dog.

Solution

Just Modify the function LineReadWrite using strlen and fprintf

```
void LineReadWrite(FILE *fin, FILE *fout)
{
   char buff[MAX_LEN];
   int len;
   while (fgets(buff, MAX_LEN, fin) != NULL)
   {
      len = strlen(buff);
      fprintf(fout, "%d %s", len, buff);
      printf("%s", buff);
   }
}
```

Homework

- Write a program to read a text file created with emacs. Put a line number to the head of the line and output the contents of the file to the standard output. A text file name can be specified as the argument to the program.

- For example, the following content of a text file

  This is sample file.
  Hello!

- is output as follows.

  1 This is sample file.
  2 Hello!

See you next time

Copy a File

- Write a program that copy one text file to another.

```
#include <stdio.h>

  main()    /* FILE_COPY.C     */
  {
     char in_name[25], out_name[25];
     FILE *in_file, *out_file, *fopen ();
     int c;

     printf("File to be copied:\n");
     scanf("%24s", in_name);
     printf("Output filename:\n");
     scanf("%24s", out_name);

     in_file = fopen ( in_name, "r");

     …
```

```
if( in_file == NULL )
    printf("Cannot open %s for reading.\n",
    in_name);
    else {
          out_file = fopen (out_name, "w");
          if( out_file == NULL )
                printf("Can't open %s for
                      writing.\n",out_name);
          else {
                while( (c = getc( in_file)) != EOF
)
                      putc (c, out_file);
                putc (c, out_file);   /* copy EOF
*/
                printf("File has been copied.\n");
                fclose (out_file);
          }
          fclose (in_file);
    }
}
    …
```