Lecture09: File I/O
11/19/2012

Slides modified from Yin Lou, Cornell CS2022: Introduction to C

1

File I/O

- Before a file can be read or written, it has to be opened by the library function fopen. fopen takes an external name like data.txt, does some housekeeping and negotiation with the operating system, and returns a pointer to be used in subsequent reads or writes of the file.
- This pointer points to a structure FILE.

```
FILE *fp;
```

Text vs. Binary Files

- Text files are divided into lines. Each byte in a text file represents a character, therefore readable by humans
- In binary files, each byte may not be a character.

File operations

- Open a file: `fopen()`
- Close a file: `fclose()`
- Read a binary file: `fgetc(), getc(), fgets(), puts(), fscanf(), fread()`
- Write a binary file: `fputc(), putc(), fputs(), puts(), fprintf(), fwrite()`
- File positioning: `fseek(), ftell(), fgetpos(), fsetpos()`

fopen()

```
FILE *fopen(char *name, char *mode);
void fclose(FILE* stream)
```

- fopen returns a pointer to a `FILE`.
- mode can be
  - "r" - read
  - "w" - write
  - "a" - append
  - "b" can be appended to the mode string to work with binary files. For example, "rb" means reading binary file.

Text Files – fprintf()

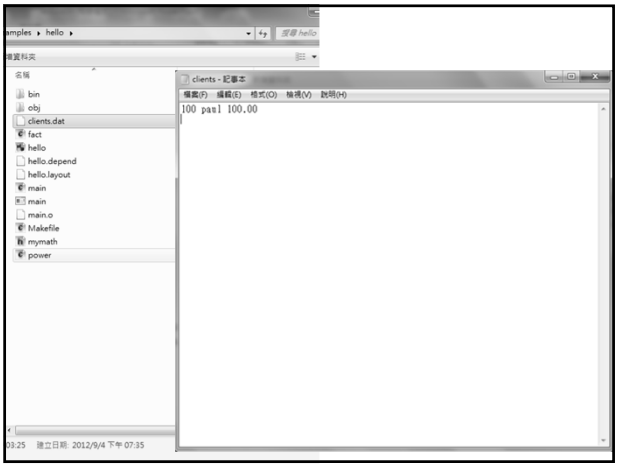
```
int fprintf(FILE *fp, char *format, ...);
```

Similar to printf.

On success, the total number of characters written is returned. If a writing error occurs, a negative number is returned.

Example – create and write to a file

```
#include <stdio.h>
int main()
{
   FILE *fp;
   char name[10];
   double balance;
   int account;
   if ((fp = fopen("clients.dat", "w")) == NULL) {
       printf("File could not be opened\n");
   }
   else {
       printf("Enter one account, name, and balance.\n");
       scanf("%d%s%lf", &account, name, &balance);
       fprintf(fp, "%d %s %.2f\n", account, name, balance);
       fclose(fp);
   }
   return 0;
}
```



Text Files – fscanf()

`int fscanf(FILE *fp, char *format, ...);`

- Similar to scanf.
- On success, return the number of items successfully filled. This count can match the expected number of items or be less (even zero) due to a matching failure, a reading error, or the reach of the *end-of-file*. And, if *end-of-file* happens before any data could be successfully read, EOF is returned.

`int feof(FILE *fp);`

- return 1/0 end-of-file is reached

Text Files – read from a file

```
#include <stdio.h>
int main()
{
   FILE *fp;
   char name[10];
   double balance;
   int account;
   if ((fp = fopen(“clients.dat”, “r”)) == NULL) {
       printf(“File could not be opened\n”);
   }
   else {
       fscanf(fp, “%d%s%lf”, &account, name, &balance);
       printf("%d %s %.2f\n", account, name, balance);
       fclose(fp);
   }
   return 0;
}
```

Text Files – character I/O

```
int fputc(int c, FILE *fp);
int putc(int c, FILE *fp);
```

Write a character c to a file. putc() is often implemented as a MACRO (hence faster). On success, the character written is returned. If a writing error occurs, EOF is returned

```
int fgetc(FILE *fp);
int getc(FILE *fp);
```

Read a character c to a file. getc() is often implemented as a MACRO (hence faster). On success, the character read is returned. If a read error occurs, EOF is returned.

Text Files – character I/O

```
#include <stdio.h>
int main()
{
   FILE *source_fp, *dest_fp;
   int ch;

   if ((source_fp = fopen("source.txt", "r")) == NULL)
         printf("cannot open source file\n");
   if ((dest_fp = fopen("dest.txt", "w")) == NULL)
         printf("cannot open dest file\n");
   while ((ch = getc(source_fp)) != EOF)
         putc(ch, dest_fp);

   fclose(source_fp);
   fclose(dest_fp);
   return 0;
}
```

Text Files – character I/O

`int ugetc(int c, FILE *fp);`

Push back a character read from a file pointer.

`int feof(FILE *fp);`

return 1/0 *end-of-file* is reached

Text Files – character I/O

```
#include <stdio.h>
int main ()
{
  FILE * fp;
  int c;
  fp = fopen ("source.txt","r");
  if (fp == NULL) {
    printf("cannot open the file\n");
    return 0;
  }
  while (!feof (fp)) {
    c = getc(fp);
    if (c == '#')
        ungetc('@', fp);
    else
        putc(c, stdout); // stdout is the screen
  }
  return 0;
}
```

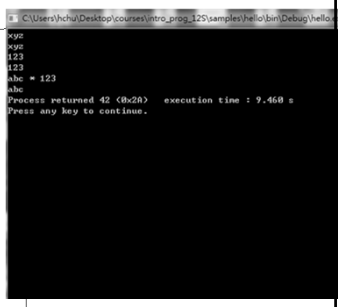
Text Files – standard input & output

- `FILE *stdin  // screen input as a file`
- `FILE *stdout // screen output as a file`

Text Files – stdin, stdout

```
#include <stdio.h>

int main ()
{
    int c;
    while ((c =
   fgetc(stdin)) != '*')
    {
        fputc(c, stdout);
    }
}
```



In-Class Exercise 9.1

Write a program that converts all letters in a file, called "source.txt" to upper case. (Characters other than letters shouldn't be changed) The program should obtain the file name from the command line and write its output to stdout.

Text Files – Line I/O

`int fputs(const char *s, FILE *fp);`

Write a line of characters to a file. On success, a non-negative value is returned. On error, the function returns EOF.

`char* fgets(char *s, int n, File *fp);`

Read characters from a file until it reaches the first new-line or (n-1) characters, in which it places the NULL character ('\0') at the end of the string.

On success, the function returns s. If the end-of-file is encountered before any characters could be read, the pointer returned is a NULL pointer (and the contents of s remain unchanged).

Text Files – Line I/O

```
#include <stdio.h>
int main()
{
   FILE *source_fp, *dest_fp;
   char s[100];

   if ((source_fp = fopen("source.txt", "r")) == NULL)
         printf("cannot open source file\n");
   if ((dest_fp = fopen("dest.txt", "w")) == NULL)
         printf("cannot open dest file\n");

   while (fgets(s, 100, source_fp) != NULL)
         fputs(s, dest_fp);

   fclose(source_fp);
   fclose(dest_fp);
   return 0;
}
```

In-Class Exercise 9.2

Write a program that reads a text file "source.txt", counts the number of characters, the number of words, and the number of lines in this text file, and outputs these numbers on the screen.

Binary Files – fread() and fwrite()

```
size_t fread(void *array, size_t size, size_t count,
  FILE *fp);
size_t fwrite(void *array, size_t size, size_t
  count, FILE *fp);
```

- array must be a pointer
- size - size of elements in this array
- count - number of elements in this array
- Return the total number of elements successfully read or written.

Binary Files: read from a file

```
#include <stdio.h>
int main()
{
   FILE *fp;
   float value[3];
   fp = fopen(“account.txt”, "rb");
   fread(value, sizeof(float), 3, fp);
   printf("%f\t%f\t%f\n", value[0], value[1], value[2]);
   fclose(fp);
   return 0;
}
```

Binary Files: write to a file

```
#include <stdio.h>
int main()
{
   FILE *fp;
   float value[3] = {1.0, 2.0, 3.0};
   fp = fopen(“account.txt”, “wb");
   fwrite(value, sizeof(float), 3, fp);
   fclose(fp);
   return 0;
}
```

File positioning

Every opened file has a **file position** for the next read or write. When a file is first opened, the file position is set at the beginning of a file. When any read or write is performed, the file position moves automatically.

`long int ftell(FILE *fp);`

Return the current file position (byte offset from the start of a file) as a long integer.

`int fseek(FILE *fp, long int offset, int whence);`

Change the current file position to offset relative to whence.

File positioning

```
int fseek(FILE *fp, long int offset, int whence);
```

Change the current file position to offset relative to whence. Whence can be

SEEK_SET	Beginning of file
SEEK_CUR	Current file position
SEEK_END	End of file

File positioning – fseek & ftell

```
#include <stdio.h>

int main ()
{
    FILE *fp;
    long int size;
    fp = fopen ("example.txt", "r");
    if (fp == NULL)
        printf("Error opening the file\n");

    fseek(fp, 0, SEEK_END);
    size = ftell(fp);
    fclose(fp);
    printf("Size of example.txt: %ld bytes.\n", size);
    return 0;
}
```

In-Class Exercise 9.3

```
#include <stdio.h>
int main()
{
  FILE* fp;
  fp = fopen("example.txt",
   "w");
  fputs("This is an apple.",
   fp);
  fseek(fp, ? , SEEK_SET);
  fputs(" sam", fp);
  fclose(fp);
  return 0;
}
```

Modify the left program such that the file content will be changed to “This is a sample.”

Change ? with a correct offset number.