二進位檔 (Binary Files) 的 I/O

Mode for Binary Files

- Mode strings for binary files:

String	*Meaning*
`"rb"`	Open for reading
`"wb"`	Open for writing (file need not exist)
`"ab"`	Open for appending (file need not exist)
`"r+b"` or `"rb+"`	Open for reading and writing, starting at beginning
`"w+b"` or `"wb+"`	Open for reading and writing (truncate if file exists)
`"a+b"` or `"ab+"`	Open for reading and writing (append if file exists)

Block I/O

- The `fread` and `fwrite` functions allow a program to read and write large blocks of data in a single step.

Block I/O

- `fwrite` is designed to copy an array from memory to a stream.
- Arguments in a call of `fwrite`:
  - Address of array
  - Size of each array element (in bytes)
  - Number of elements to write
  - File pointer
- A call of `fwrite` that writes the entire contents of the array `a`:

```
fwrite(a, sizeof(a[0]),
       sizeof(a) / sizeof(a[0]), fp);
```

Block I/O

- `fwrite` returns the number of elements actually written.
- This number will be less than the third argument if a write error occurs.

Block I/O

- `fread` will read the elements of an array from a stream.
- A call of `fread` that reads the contents of a file into the array `a`:

```
n = fread(a, sizeof(a[0]),
          sizeof(a) / sizeof(a[0]), fp);
```

- `fread`'s return value indicates the actual number of elements read.
- This number should equal the third argument unless the end of the input file was reached or a read error occurred.

Block I/O

- `fwrite` is convenient for a program that needs to store data in a file before terminating.
- Later, the program (or another program) can use `fread` to read the data back into memory.
- The data doesn't need to be in array form.
- A call of `fwrite` that writes a structure variable `s` to a file:

```
fwrite(&s, sizeof(s), 1, fp);
```

移動檔案指標的位置

File Positioning

- Every stream has an associated ***file position.***
- When a file is opened, the file position is set at the beginning of the file.
  - In “append” mode, the initial file position may be at the beginning or end, depending on the implementation.
- When a read or write operation is performed, the file position advances automatically, providing sequential access to data.

File Positioning

- The `fseek` function changes the file position associated with the first argument (a file pointer).
- The third argument is one of three macros:

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

- The second argument, which has type `long int`, is a (possibly negative) byte count.

File Positioning

- Using `fseek` to move to the beginning of a file:

```
fseek(fp, 0L, SEEK_SET);
```

- Using `fseek` to move to the end of a file:

```
fseek(fp, 0L, SEEK_END);
```

- Using `fseek` to move back 10 bytes:

```
fseek(fp, -10L, SEEK_CUR);
```

- If an error occurs (the requested position doesn't exist, for example), `fseek` returns a nonzero value.

File Positioning

- The file-positioning functions are best used with binary streams.
- C doesn’t prohibit programs from using them with text streams, but certain restrictions apply.
- For text streams, `fseek` can be used only to move to the beginning or end of a text stream or to return to a place that was visited previously.
- For binary streams, `fseek` isn’t required to support calls in which the third argument is `SEEK_END`.

File Positioning

- The `ftell` function returns the current file position as a long integer.
- The value returned by `ftell` may be saved and later supplied to a call of `fseek`:

```
long file_pos;
…
file_pos = ftell(fp);
  /* saves current position */
…
fseek(fp, file_pos, SEEK_SET);
  /* returns to old position */
```

File Positioning

- If `fp` is a binary stream, the call `ftell(fp)` returns the current file position as a byte count, where zero represents the beginning of the file.
- If `fp` is a text stream, `ftell(fp)` isn't necessarily a byte count.
- As a result, it's best not to perform arithmetic on values returned by `ftell`.

File Positioning

- The `rewind` function sets the file position at the beginning.
- The call `rewind(fp)` is nearly equivalent to `fseek(fp, 0L, SEEK_SET)`.
  - The difference? `rewind` doesn't return a value but does clear the error indicator for `fp`.

File Positioning

- `fseek` and `ftell` are limited to files whose positions can be stored in a long integer.
- For working with very large files, C provides two additional functions: `fgetpos` and `fsetpos`.
- These functions can handle large files because they use values of type `fpos_t` to represent file positions.
  - An `fpos_t` value isn't necessarily an integer; it could be a structure, for instance.

File Positioning

- The call `fgetpos(fp, &file_pos)` stores the file position associated with `fp` in the `file_pos` variable.
- The call `fsetpos(fp, &file_pos)` sets the file position for `fp` to be the value stored in `file_pos`.
- If a call of `fgetpos` or `fsetpos` fails, it stores an error code in `errno`.
- Both functions return zero when they succeed and a nonzero value when they fail.

File Positioning

- An example that uses `fgetpos` and `fsetpos` to save a file position and return to it later:

```
fpos_t file_pos;
…
fgetpos(fp, &file_pos);
  /* saves current position */
…
fsetpos(fp, &file_pos);
  /* returns to old position */
```

Program: Modifying a File of Part Records

- Actions performed by the `invclear.c` program:
  - Opens a binary file containing part structures.
  - Reads the structures into an array.
  - Sets the `on_hand` member of each structure to 0.
  - Writes the structures back to the file.
- The program opens the file in `"rb+"` mode, allowing both reading and writing.

invclear.c

```
/* Modifies a file of part records by setting the quantity
   on hand to zero for all records */

#include <stdio.h>
#include <stdlib.h>

#define NAME_LEN 25
#define MAX_PARTS 100

struct part {
  int number;
  char name[NAME_LEN+1];
  int on_hand;
} inventory[MAX_PARTS];

int num_parts;
int main(void)
{
  FILE *fp;
  int i;

  if ((fp = fopen("inventory.dat", "rb+")) == NULL) {
    fprintf(stderr, "Can't open inventory file\n");
    exit(EXIT_FAILURE);
  }

  num_parts = fread(inventory, sizeof(struct part),
                    MAX_PARTS, fp);

  for (i = 0; i < num_parts; i++)
    inventory[i].on_hand = 0;

  rewind(fp);
  fwrite(inventory, sizeof(struct part), num_parts, fp);
  fclose(fp);

  return 0;
}
```

使用暫存檔 (Temporary File)

Temporary Files

- Programs often need to create temporary files—files that exist only as long as the program is running.
- `<stdio.h>` provides two functions, `tmpfile` and `tmpnam`, for working with temporary files.

Temporary Files

- `tmpfile` creates a temporary file (opened in `"wb+"` mode) that will exist until it's closed or the program ends.
- A call of `tmpfile` returns a file pointer that can be used to access the file later:

```
FILE *tempptr;
…
tempptr = tmpfile();
  /* creates a temporary file */
```

- If it fails to create a file, `tmpfile` returns a null pointer.

Temporary Files

- Drawbacks of using `tmpfile`:
  - Don’t know the name of the file that `tmpfile` creates.
  - Can’t decide later to make the file permanent.
- The alternative is to create a temporary file using `fopen`.
- The `tmpnam` function is useful for ensuring that this file doesn’t have the same name as an existing file.

Temporary Files

- `tmpnam` generates a name for a temporary file.
- If its argument is a null pointer, `tmpnam` stores the file name in a static variable and returns a pointer to it:

```
char *filename;
…
filename = tmpnam(NULL);
  /* creates a temporary file name */
```

Temporary Files

- Otherwise, `tmpnam` copies the file name into a character array provided by the programmer:

```
char filename[L_tmpnam];
…
tmpnam(filename);
  /* creates a temporary file name */
```

- In this case, `tmpnam` also returns a pointer to the first character of this array.
- `L_tmpnam` is a macro in `<stdio.h>` that specifies how long to make a character array that will hold a temporary file name.