

CSc 352

Binary File IO

Benjamin Dicken

File Content

- Recall that files on a UNIX system are iNodes, that have pointers to data blocks, where the actual data of a file is stored
- Those blocks are just a bunch of 1's and 0's
- We can choose how to interpret when we read
- We can choose the format when we write

File Content

- Many of the files we have dealt with on UNIX in this course have been “text” files
 - *.c *.py *.txt *.stl makefile
 - This is just because we wrote text to those, and used programs that interpret files as text (vim)
- What have we used that are *NOT* text files?
- A “binary file” is just a file that we treat as information represented in RAW binary, rather than ASCII characters

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

```
int main() {
```

```
    uint32_t number = 10000000;
```

```
    FILE* text = fopen("text", "w");
```

```
    fprintf(text, "%u", number);
```

```
    fclose(text);
```

```
    FILE* binary = fopen("binary", "wb");
```


```
    fwrite(&number, 1, sizeof(number), binary);
```

```
    fclose(binary);
```

```
    return 0;
```

```
}
```

What is this?



What is this?



Tools for viewing file contents

```
$ hexdump file_name
```

```
$ xxd -b file_name
```

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

int main() {
    uint64_t number = 20;

    FILE* text = fopen("text", "w");
    fprintf(text, "%lu", number);
    fclose(text);

    FILE* binary = fopen("binary", "wb");
    fwrite(&number, 1, sizeof(number), binary);
    fclose(binary);

    return 0;
}
```

Which file represents the number more efficiently?

Data Representation

Each row represents:

studentID, exam 1, exam 2, final exam

How many bytes would it take to represent this with a CSV ASCII file?

How many bytes would it take to represent this in binary? How compact could we get it?

grade_info.csv

19311233,80,90,100

91246834,75,85,82

21245122,43,76,87

18673124,90,75,90

Implement Conversion

Write the code to:

- Open this text file
- Re-write the same data to **binary_grade_info.bin**
- Close the file

grade_info.csv

```
193112338090100
91246834,5,5,100
21245122,43,76,87
18673124,90,75,90
```


Sum the numbers

Write a program that:

- Asks the user for a file name,
- Sums the numbers
- Prints the result

Assume that the file is formatted in binary and has alternating 8-byte integers (`uint64_t`) and 4-byte floats (`float`)

Use **`fread`**

Use:

`/tmp/352numbers`

and

`/tmp/more352numbers`

to test

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

int main(int argc, char* argv[]) {
    FILE* f = fopen(argv[1], "rb");
    int i = 0;
    int r = 1;
    double sum = 0;
    while(r) {
        if (i%2 == 0) {
            uint64_t temp = 0;
            r = fread(&temp, sizeof(uint64_t), 1, f);
            sum += temp;
        } else {
            float temp = 0.0;
            r = fread(&temp, sizeof(float), 1, f);
            sum += temp;
        }
        i++;
    }
    fclose(f);
    printf("SUM: %lf\n", sum);
    return 0;
}
```

ELF

Executable and Linkable Format

The standard binary executable format for UNIX systems on x86 processors

A type of binary file!

Investigate ELF Files

```
$ file a.out
```

```
$ ldd a.out
```

```
$ readelf -h a.out
```

```
$ objdump -d a.out
```