

CMSC201

Computer Science I for Majors

Lecture 20 – Binary (and File I/O)

Last Class We Covered

- File I/O
- How to open a file
 - For reading or writing
- How to read from a file
- How to write to a file
- How to close a file

Any Questions from Last Time?

Today's Objectives

- To understand how data is represented and stored in memory
 - Binary numbers
 - Converting
 - Binary to Decimal
 - Decimal to Binary
- To review what we learned about file I/O

“Bridge Course”

- We are offering CMSC 291 again this summer
 - Course for CMSC/CMPE students who earn a “C” instead of the “B” required for their major
 - Grade must be result of a single poor score (*e.g.*, did badly on the midterm or a project)
 - Won’t change CMSC 201 grade, but will allow eligible students to take CMSC 202 in Fall 18
- An announcement was made on Blackboard containing all of the details last week

Binary Numbers

Binary Numbers

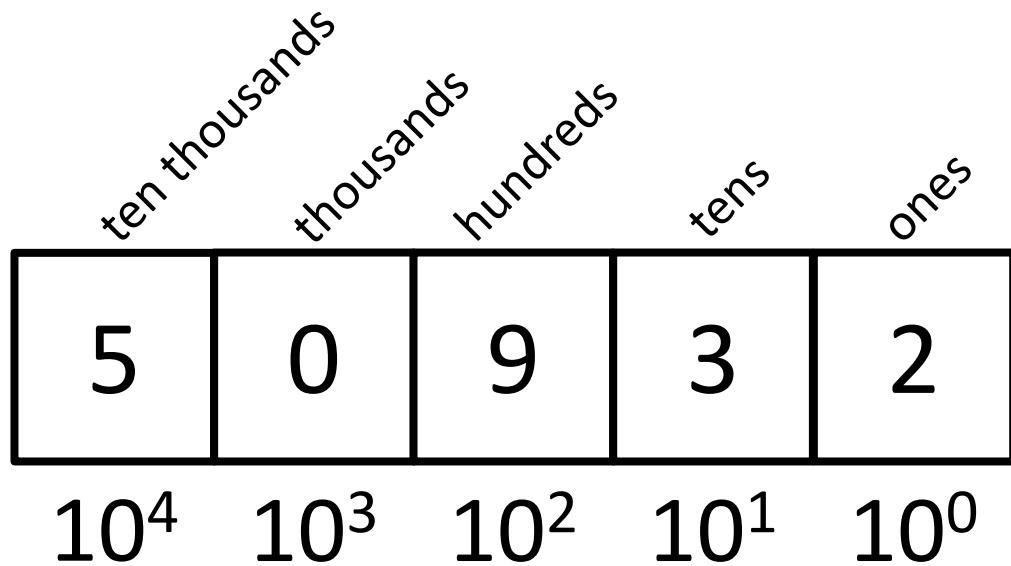
- Computers store all information (code, text, images, sound,) as a binary representation
 - “Binary” means only two parts: 0 and 1
- Specific formats for each file help the computer know what type of item/object it is
- But why use binary?

Decimal vs Binary

- Why do we use decimal numbers?
 - Ones, tens, hundreds, thousands, etc.
- But computers don't have fingers...
 - What do they have instead?
- They only have two states: “on” and “off”

Decimal Example

- How do we represent a number like 50,932?



$$\begin{array}{r}
 2 \times 10^0 = 2 \\
 3 \times 10^1 = 30 \\
 9 \times 10^2 = 900 \\
 0 \times 10^3 = 0000 \\
 5 \times 10^4 = 50000 \\
 \hline
 \text{Total: } 50932
 \end{array}$$

Decimal uses 10 digits, so...

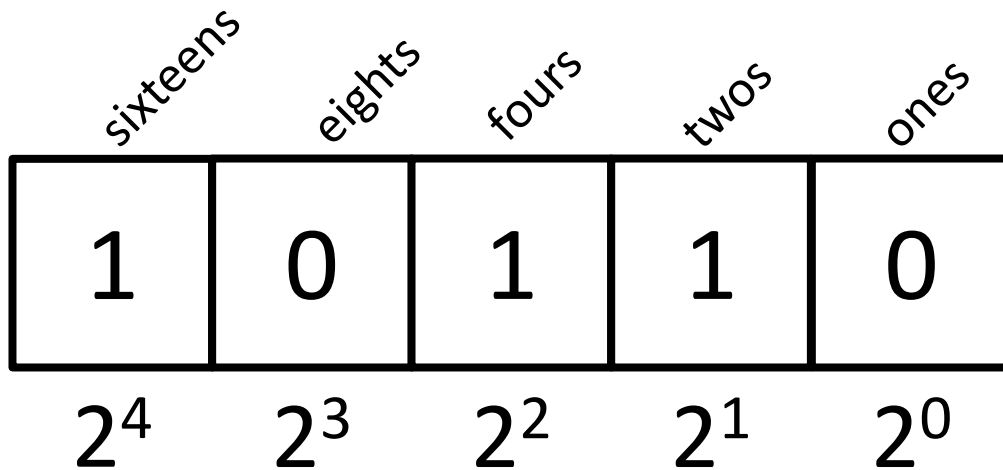
Another Decimal Example

| | | | | |
|--------|--------|--------|--------|--------|
| 6 | 7 | 4 | 9 | 3 |
| 10^4 | 10^3 | 10^2 | 10^1 | 10^0 |
| 10000 | 1000 | 100 | 10 | 1 |
| 60000 | 7000 | 400 | 90 | 3 |

$$60000 + 7000 + 400 + 90 + 3 = 67493$$

Binary Example

- Let's do the same with 10110 in binary



$$\begin{array}{r}
 0 \times 2^0 = 0 \\
 1 \times 2^1 = 2 \\
 1 \times 2^2 = 4 \\
 0 \times 2^3 = 0 \\
 1 \times 2^4 = 16 \\
 \hline
 \text{Total: } 22
 \end{array}$$

Binary uses 2 digits, so our base isn't 10, but...

Binary to Decimal Conversion

- Step 1: Draw Conversion Box
- Step 2: Enter Binary Number
- Step 3: Multiply
- Step 4: Add

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 2^7 | 2^6 | 2^5 | 2^4 | 2^3 | 2^2 | 2^1 | 2^0 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 128 | 0 | 0 | 0 | 8 | 4 | 0 | 1 |

$$128 + 0 + 0 + 0 + 8 + 4 + 0 + 1 = 141$$

Exercise: Converting From Binary

- What are the decimals equivalents of...

101


1111

100000

101010

0010 1010

1000 0000



Longer binary numbers are often broken into blocks of four digits for the sake of readability

Exercise: Converting From Binary

- What are the decimals equivalents of...

$$101 = 4+0+1 = 5$$

$$1111 = 8+4+2+1 = 15$$

$$100000 = 32+0+0+0+0+0 = 32$$

$$101010 = 32+0+8+0+2+0 = 42$$

$$0010 \ 1010 = 32+0+8+0+2+0 = 42$$

$$1000 \ 0000 = 128+\dots+0+0 = 128$$

Decimal to Binary Conversion

- Step 1: Draw Conversion Box
- Step 2: Compare decimal to highest binary value
- Step 3: If binary value is smaller, put a 1 there and subtract the value from the decimal number
- Step 4: Repeat until 0

Convert 163 to binary

| | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 2^7 | 2^6 | 2^5 | 2^4 | 2^3 | 2^2 | 2^1 | 2^0 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

$$163 - 128 = 35$$

$$35 - 32 = 3$$

$$3 - 2 = 1$$

$$1 - 1 = 0$$

Converting to Binary

- What are the binary equivalents of...

9

27

68

216

255

Converting to Binary

- What are the binary equivalents of...

$$9 = 1001 \text{ (or } 8+1)$$

$$27 = 0001 \ 1011 \text{ (or } 16+8+2+1)$$

$$68 = 0100 \ 0100 \text{ (or } 64+4)$$

$$216 = 1101 \ 1000 \\ \text{(or } 128+64+16+8)$$

$$255 = 1111 \ 1111 \\ \text{(or } 128+64+32+16+8+4+2+1)$$

Binary Tips and Tricks

- Some “sanity checking” rules for conversions:
 1. Binary can only be 1 or 0
 - If you get “2” of something, it’s wrong
 2. Odd numbers must have a 1 in the ones column
 - Why? (And what’s the rule for even numbers?)
 3. Each column’s value is the sum of all of the previous columns (to the right) plus one
 - In decimal, what column comes after 999?

File Input and Output (Review)

Quick Review

- Write the lines of code for the tasks below
 1. Open the file “goodDogs.txt”
 2. Read the file in (however you want), and print out each dog’s name in the sentence “X is a good dog”
 3. Finish using the file (what do you need to do?)

```
goodDogs.txt
Thor, Corgi
Coco, Chocolate Lab
Beethoven, St. Bernard
```

Exercise: Jabberwocky

- Write a program that goes through a file and reports the longest line in the file

Example Input File:

carroll.txt

```
Beware the Jabberwock, my son,  
the jaws that bite, the claws that catch,  
Beware the JubJub bird and shun  
the frumious bandersnatch.
```

Example Output:

```
>>> longest.py  
longest line = 42 characters  
the jaws that bite, the claws that catch,
```

Jabberwocky Solution Pseudocode

inside main:

open the file "carroll.txt" (for reading)

create a variable to store the "longest" line

we'll refer to this variable as "record"

what should this variable be initialized to?

for each line of the input

if the current line is longer than the record

update the record to the current line

print the length of the longest line

print the longest line

call main


Jabberwocky Solution Code

```
def main():
    inputFile = open("carroll.txt")
    longest = ""
    lines = inputFile.readlines()
    for i in range(len(lines)):
        if len(lines[i]) > len(longest):
            longest = lines[i]

    print("Longest line =", len(longest))
    print(longest)
```

```
main()
```

Jabberwocky Solution Walkthrough

`line =`  Beware the Jabberwock, my son,
the jaws that bite, the claws that catch,
Beware the JubJub bird and shun
the frumious bandersnatch.

`line = "Beware the Jabberwock, my son,"`


~~`longest = ""`~~

`longest = "Beware the Jabberwock, my son,"`


`len(line) > len(longest)`

31 > 0



 `for i in range(len(lines)):`
 `if len(lines[i]) > len(longest)`
 `longest = lines[i]`

Jabberwocky Solution Walkthrough

`line =` 

```
Beware the Jabberwock, my son,
the jaws that bite, the claws that catch,
Beware the JubJub bird and shun
the frumious bandersnatch.
```

```
line = "the jaws that bite, the claws that catch,"
```

```
longest = ""
```


```
longest = "Beware the Jabberwock, my son,"
```

```
longest = "the jaws that bite, the claws that catch,"
```


```
len(line) > len(longest)
```

```
42 > 31
```



```
 for i in range(len(lines)):
    if len(lines[i]) > len(longest):
        longest = lines[i]
```

Jabberwocky Solution Walkthrough

`line =` 

```
Beware the Jabberwock, my son,
the jaws that bite, the claws that catch,
Beware the JubJub bird and shun
the frumious bandersnatch.
```

```
line = "Beware the JubJub bird and shun"
```

```
longest = ""
```

```
longest = "Beware the Jabberwock, my son,"
```

```
longest = "the jaws that bite, the claws that catch,"
```

```
len(line) > len(longest)
```

```
32 > 42
```






```
for i in range(len(lines)):
    if len(lines[i]) > len(longest)
        longest = lines[i]
```

Jabberwocky Solution Walkthrough

```
Beware the Jabberwock, my son,
the jaws that bite, the claws that catch,
Beware the JubJub bird and shun
the frumious bandersnatch.
```

`line =` 

```
line = "the frumious bandersnatch."
```

```
longest = ""
```


```
longest = "Beware the Jabberwock, my son,"
```

```
longest = "the jaws that bite, the claws that catch,"
```

```
len(line) > len(longest)
```

```
27 > 42
```



```
 for i in range(len(lines)):
    if len(lines[i]) > len(longest)
        longest = lines[i]
```

Daily CS History

- Katherine Johnson
 - Worked as a NASA “computer”
 - Calculated trajectories, launch windows, and return paths for flights in Project Mercury
 - Plotted Alan Shepard’s 1961 journey to space (first American)
 - Also examined black box data from crashed air planes
 - Graduated college at age 18



Announcements

- Homework 6 is available on Blackboard
 - Parts 4 and 5 do not require recursion
 - Homework is due on Friday, April 27th
- Final exam is when?
 - Friday, May 18th from 6 to 8 PM
 - If you can't take the exam then, you need to let Dr. Gibson know via email by **Wednesday @ 9 PM**

Image Sources

- Katherine Johnson:
 - https://commons.wikimedia.org/wiki/File:Katherine_Johnson_at_NASA,_in_1966.jpg