

Abstraction and Representation with Bits

Please do problems 1.3, 1.8, 2.2, 2.10 from the textbook. Solutions to all odd-numbered problems are available online; please make sure that you understand how to solve the problems.

Here are four additional problems for this week:

1. The Water Faucet Abstraction

Humans use abstraction layers in every discipline of engineering. In this problem we ask you to think about the meaning of abstraction layers in a familiar context.

A water faucet in a kitchen or bathroom provides an abstraction that simplifies our use of water. Even people who do not know how such a device is implemented can make use of one.

A. What operations are provided to a human user by a faucet?

B. Briefly explain at least two ways in which these operations can be implemented. (You may want to look up real implementations, or just be imaginative.) Include a simple diagram for each implementation.

2. Required Number of Bits

For each of the following, calculate the number of bits needed to uniquely represent the specified item. If you need to make any assumptions, write them down for us.

A. A human living on Earth.

B. One byte in a computer's memory.

C. The winning combination in a lottery in which two numbers are chosen from the range 1 to 100. In a lottery, the numbers chosen must be different, and the order in which the two numbers are chosen does not matter.

3. Ambiguity in Representations

Decades ago, telephone companies created a mapping from English letters into digits in order to help humans memorize telephone numbers. For example, a rental car company might obtain the number corresponding to the words "CAR RENT". The representation maps multiple letters into a single digit: for example, the letters A, B, and C are all represented by the digit 2. You have probably seen a variant of this same code when sending text messages with old cell phones.

Explain why this mapping does not make a good representation for use by computers. In particular, could we store English text as a sequence of decimal digits?

4. Examining 2's Complement

Each of your homeworks will include a programming problem. For the first couple of weeks—until we have introduced you to the C programming language—these assignments will involve only obtaining and using programs. As you learn C, however, we encourage you to look at these programs and see how they work.

Starting in your home directory, obtain a copy of the `hw1` directory from the class directory:

```
cp -r /class/ece199/hw1 .
```

Then change into the `hw1` directory (using: `cd hw1`) and build the program by typing: `make`.

You can run the program from the `hw1` directory by typing: `./hw1`

Use the program to solve problem 2.11 from the textbook.