Introduction to Computer and Information Science

CIS 110, Fall 2015

Project 2 – Encoding and decoding digital data

All data in a computer system is represented by two digits: 0 and 1. These digits are used to encode all types of data, including text, numeric values, photos, sound, video, and more.

In this project, you will work with the two most basic types of digital data: text and numbers. You will start by encoding your name into binary (0 and 1) code, and then will create a Quick Response (QR) code. You will conclude this project by encoding and decoding several numeric values.

Complete your project with a word processing program. Include your name, the date, and the project number at the top of your project. The expected project length is 2 pages, single spaced.

1. Encoding text

   Text data includes letters (upper and lower case), numbers, and special symbols (! @ # $ % ^ & * and more). Each of these is represented by a unique binary code. There are several coding schemes that have been invented over the years. The most common of these is the American Standard Code for Information Interchange (ASCII). In the *extended* version of the ASCII code, each text character is represented by 8 digits. Each digit is a "bit" and the group of 8 bits is a "byte."

   Here are a few examples:

Letter	ASCII value
A	01000001
B	01000010
C	01000011
a	01100001
b	01100010
c	01100011

   Use the Extended ASCII code to write your first and last names in binary code. Here is an example of the format to use:

```
01000010 01110010 01111001 01100011 01100101 00100000
B        r        y        c        e        space

01001101 01100001 01110010 01110100 01100101 01101110 01110011
M        a        r        t        e        n        s
```

   You may do this using an Extended ASCII chart. There's a chart in the textbook (see page 20) or you may refer to an online chart located on the following web page:

http://www.smccd.edu/accounts/martens/ascii.htm

Alternatively, you may use an online tool to do the conversion for you. Here is such a conversion tool:

http://www.binaryhexconverter.com/ascii-text-to-binary-converter

You will need to "cut and paste" the binary code from the converter to your word processing document. Here's how to do this:

- In Windows, use the mouse to highlight the binary code. Then use the Ctrl and C keys to copy the highlighted text to the Windows clipboard. Finally, use the Ctrl and V keys to paste the contents of the clipboard into your word processing document.
- In Mac OS X, use the mouse to highlight the binary code. Then use the Command and C keys to copy the highlighted text. Finally use the Command and V keys to paste the binary code into your word processing document.

2. Creating a Quick Response (QR) code

In 1994, the Japanese auto manufacturing industry started using two-dimensional barcodes to track component parts as a car was being built. This type of barcode began to take on wider use in the late 1990's. Today, the Quick Response (QR) code is used to encode all kinds of data, including web page names – known as Uniform Resource Locators (URL) – and other types of data (i.e., text, emails, etc.). Here are two examples. The first is encoded text and the second is an encoded URL.

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If you have a QR reader app on your phone or tablet, try scanning these codes and you'll see that they work.

There are many online tools that can be used to create QR codes. Use one of these tools to create a QR code for your first and last names. Here is a recommended web site:

http://zxing.appspot.com/generator/

Instructions: For the "Contents" option (at the top of the screen), choose "Text." Type your name in the "Text content" box and click the "Generate" button. Then click the "Download" link.

You will need to "cut and paste" the QR code from the generator to your word processing document. Here's how to do this:

- In Windows, right click the mouse on the QR code. Choose the "Copy" option to copy the QR code to the Windows clipboard. Finally, use the Ctrl and V keys to paste the contents of the clipboard into your word processing document.
- In Mac OS X, use the control button with a mouse click to copy the image. Then use the Command key with the V key to paste the image into your word processing document.

3. Converting binary number to decimal numbers

In part 1 of this project, you converted text into binary code. For this part of the project, you will convert numbers from the binary system to the decimal system. You do this by using the place values of the numbers. In the decimal system, each place has a value of 10 times the previous place. Thus, we have the 1's place, the 10's place, the 100's place, the 1000's place, and so on.

With the binary numbering system, the place values are based on 2 (rather than 10). This means that we have the 1's place, followed by the 2's place, 4's place, 8's place, 16's place, and so forth. The place values continue to grow (to the left) as far as is needed to represent the number that is being encoded.

Since binary numbers consist only of 0 and 1, you end up using a lot of places to write a numeric value. The following table shows a number displayed in binary form. The top line (the blue background) shows the place values (1, 2, 4, 8, 16, etc.), and the lower line shows the binary number. The resulting value (in decimal) is the sum of the places where there is a 1 shown on the lower line. For the following example, the sum is 64 + 32 + 8 + 2 + 1 = 107.

128	64	32	16	8	4	2	1
0	1	1	0	1	0	1	1

Use this process to convert the following binary numbers into decimal numbers. Show or describe the exact method that you used for each conversion.

- 00000100
- 00000101
- 00001100

- 00010101
- 00001111
- 00010000
- 11110000
- 00110110

4. Converting decimal numbers to binary numbers

   To convert decimal numbers to binary numbers, you reverse the process that you used in part 3. Here's a summary of this process:

   a. Start with a decimal number
   b. Find the binary place value that is larger than the decimal number and write a 0 in that place
   c. Move one place to the right and write a 1 in that place
   d. Subtract that place value from the original number
   e. Take the resulting value and repeat the above process

   These steps may seem confusing at first, but a concrete example should make it clear.

   Let's say you want to convert the decimal number 117 into its binary form. Following the above process, you would look for the binary place value that is larger than 117. That's 128. So, write a 0 there and a 1 in the 64's place. Next, subtract 64 from 117. The result is 53. By repeating the process, you would end up with a 1 in the 32's place, a 1 in the 16's place, and so forth. The following table shows the entire binary value for 117.

128	64	32	16	8	4	2	1
0	1	1	1	0	1	0	1

   You can verify the result by adding together the place values where there is a 1 on the lower line. For this example, that is 64 + 32 + 16 + 4 + 1 = 117.

   Convert the following decimal numbers into binary numbers. Describe the process that you used for each conversion. Note: For some of the examples below, you will need to expand the binary place values beyond the 128th's place shown in the above table.

   - 100
   - 1,000
   - 255
   - 256
   - 27
   - 48
   - 112
   - 1,024

Projects may not be submitted by email. The due date is August 31.