

In-Class Exercise 04 – Numbering Systems

Topics: Numbering Systems

Summary:

For this assignment, you will perform some basic calculations and analyses on text and digital images using binary and hexadecimal numbers. By the end of this assignment, you should have a basic understanding of how text and image file sizes are calculated and how media is encoded in binary and hexadecimal form.

Reminders:

- Please don't hesitate to call on the instructor if you need help. You are also welcome and encouraged to confer with your classmates if the instructor is busy helping somebody else.
- You are welcome to take breaks at your discretion while working on this assignment. However, you are not allowed to leave for the day until the class period has ended or you have completed the assignment and turned it in.
- The instructor is always happy to look over any assignment upon request.

Please read each step carefully before completing it. Be sure to observe the rules of spelling, grammar, capitalization, and punctuation in your write-up.

Taking Screenshots:

This assignment asks you to take some screenshots. The screenshot tools are as follows:

- **Windows:** Start Menu -> All Programs -> Accessories -> Snipping Tool
- **Mac:** Command + Shift + 4 (puts an image file directly on your desktop)

Instructions:

Part I: ASCII

1. Get into groups of two.
2. Both members of your team need to choose a word or short phrase (at least six letters total and no more than three words!). It can be anything not obscene or offensive, but **don't tell your partner what you chose**. I recommend writing the word or phrase down someplace where your partner can't see it, such as a notepad or on your smartphone or tablet.
3. Download and open up the **ICE04_Template** file and save it as **LastNameFirstname_ICE04** (ex. CuneoJoshua_ICE04).
 - a. At the top of your document, record your name and your partner's name.
 - b. **Only when you are done with Part I**, record your message.
4. In your browser, go to <http://www.asciichart.com/>. Use this table to write out your choice from step 2 in ASCII decimal characters (look under the Dec column on the table). For example,

Forbidden Planet

would translate into

70 111 114 98 105 100 100 101 110 32 80 108 97 110 101 116

Please be sure to use capital and lowercase characters where appropriate and to **include spaces and punctuation marks**. Write these numbers down in your text/Word file.

5. In your browser, go to <http://www.mathsisfun.com/binary-decimal-hexadecimal-converter.html>. Use this tool to translate your decimal numbers from Step 4 into **binary** and **hexadecimal** numbers.

Binary type: 0001

Binary: 01000110

Decimal: 70

Hexadecimal: 46

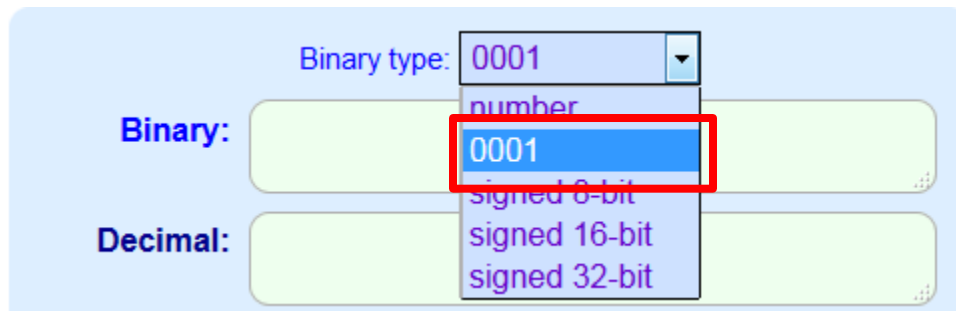
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Type your decimal numbers here, one at a time.

You are also welcome to use Windows or Mac Calculator to complete this step:

- **Windows:** Start -> All Programs -> Accessories -> Calculator, then put the Calculator in Programming mode (View -> Programmer)
- **Mac:** Finder -> Go -> Applications -> Calculator

Be sure to add enough leading zeros so that each binary number has eight digits. For instance, if the conversion tool gives me 1000110, I would write down **01000110**. You can have the converter do this for you by clicking on the drop-down menu and choosing the “0001” option.



Continuing the example from Step 4, I would get

Binary:

```
01000110 01101111 01110010 01100010 01101001 01100100 01100100
01100101 01101110 00100000 01010000 01101100 01100001 01101110
01100101 01110100
```

Hexadecimal:

```
46 6F 72 62 69 64 64 65 6E 20 50 6C 61 6E 65 74
```

Record your binary and hexadecimal numbers in your Word file.

6. Send your **hexadecimal numbers only** to your partner (email, Google Docs, or thumb drives are great ways to share this information).
7. Copy and paste your partner’s hexadecimal code into your own Word file.
8. Take your partner’s hexadecimal code and run steps 4 – 5 in reverse. Use your converter from Step 5 to turn the hexadecimal numbers back into decimal numbers (don’t worry about binary), then use the ASCII table from Step 4 to decode the message. Be sure to record both the decimal numbers and the decoded phrase in your Word file.

9. Check with your partner that you have decoded his or her message correctly.

10. In your Word file, answer the following questions:

- a. How many characters (including spaces and punctuation marks) are in your partner's message?
- b. How many **bytes** (NOT bits) does this message take up in memory?

Part II: Images

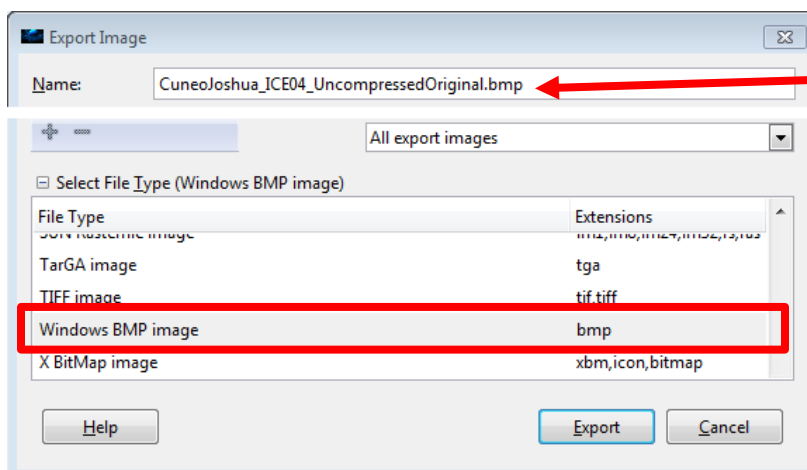
11. Go online and find any photograph of your choice. It must meet the following criteria:

- a. It must be **at least** 100 px wide by 100 px tall, but larger is better.
- b. It is in color.
- c. It has a lot of image complexity, so almost any Facebook photo would do, but an animation frame or drawing would not.
- d. The background is not black, white, or another solid color.

Download the photo to your computer and rename it to **LastnameFirstname_ICE04_Original**.

Note: If you're not sure if your image will qualify, please check with the instructor.

12. Open up your photo in GIMP, click on **Image -> Flatten Image**, and export it as an uncompressed bitmap (**File -> Export As -> Select File Type (By Extension)**), then choose "**Windows BMP Image**") named **LastnameFirstname_ICE04_UncompressedOriginal**.

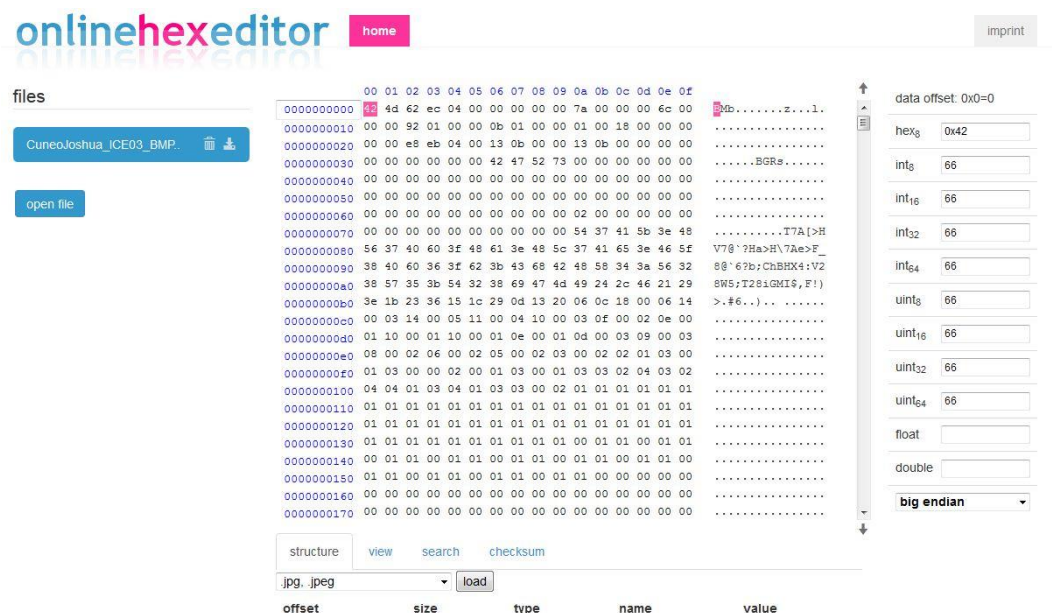


Note that your file should have a .bmp appended to the end when you select the **Windows BMP image** option

13. In your browser, go to <http://www.onlinehexeditor.com> and upload your Bitmap file from the previous step. Your screen should look something like the image below.

NOTE: The editor may not work correctly in browsers other than Firefox. If you have trouble uploading the file, or you do not get a screen like the one below after upload, try again in Firefox.

Take a screenshot of the hex editor and paste it into your Word document.



14. Go back to GIMP. Create a new image file with the same width and height of your photo, but fill it in with a solid color of your choice **other than** black, white, or grey.

HINT: With your photo still open in GIMP, go to **File -> New**. GIMP will remember the dimensions of the last opened image and will create a new image with the same width and height.

15. Export your image as an uncompressed Bitmap with the name **LastnameFirstname_ICE04_UncompressedBlank**.

16. Go back to the online hex editor and upload your file from the previous step. Take another screenshot and paste it into your Word document.

17. Describe the following:

- a. What pattern do you see in the hex editor with your image from Step 15 uploaded?
- b. Why does this pattern exist?

NOTE: Ignore the first few rows of numbers in the hex editor. This is header information. Scroll down until you see numbers repeating in a predictable pattern.

18. Check the file sizes of your two Bitmap images. Both file sizes should be equal. In your text/Word file, describe why.

HINT: Think of the three dimensions of each of the two images.

19. Assume that your Bitmap images are 24-bit (3 byte) color. Calculate the size of either one using its width and height. **Show your calculations and ensure that it is close to the file size you looked up in the last step.** Be sure to indicate correct units!

NOTE: You can get the width and height of an image by right-clicking on it and going to Properties (Windows) or Get Info (Mac).

20. In your text/Word file, express the size of either of your Bitmap images in bits, bytes, KB, MB, and GB. **Show your calculations!**

NOTE: Please do not use a conversion tool. Please do the calculation manually.

21. Go back to GIMP and open up the image you originally downloaded. Convert it to Indexed Color (**Image -> Mode -> Indexed**) and choose the “Maximum number of colors” to be a value of your choice between 8 and 32. Export your image as an uncompressed bitmap with the name **LastnameFirstname_ICE04_IndexedBitmap**.

Record the following in your text/Word file:

- a. What value did you choose for the maximum number of colors?
- b. What changes did you notice in your image when you converted to Indexed Color?
- c. What is the minimum number of bits you need to represent this many colors? (**HINT:** This should be a single-digit value.)
- d. In part c, how do you know what the minimum number of bits is? Show or describe your calculations.

22. Save your files and turn them in on D2L. You should have the following five files:

- a. LastnameFirstname_ICE04.docx (Step 3)
- b. LastnameFirstname_ICE04_Original (Step 11)
- c. LastnameFirstname_ICE04_UncompressedOriginal.bmp (Step 12)
- d. LastnameFirstname_ICE04_UncompressedBlank.bmp (Step 15)
- e. LastnameFirstname_ICE04_IndexedBitmap.bmp (Step 21)

23. When you are done with this assignment, you are free to leave.

Criteria:

Step	Points	Reason
3	4	Word file, correctly named
5	8	Your message, in decimal, hexadecimal, and binary ONLY , of appropriate length
7	8	Your partner's message, in decimal and hexadecimal
8	8	Your partner's message, decoded
10a	5	How many characters?
10b	5	How many bytes?
11	4	_Original: Photograph - 100+ px, color, no solid background, correct name
12	4	_UncompressedOriginal: Uncompressed BMP of photo, correctly named
13	4	Screenshot of hex editor of first uncompressed original image
15	4	_UncompressedBlank: Solid color version of BMP, correctly named
16	4	Screenshot of hex editor of uncompressed solid color image
17a	5	What pattern do you see?
17b	5	Why does this pattern exist?
18	4	Why are the two BMPs the same size
19	4	Size, with calculations shown
20	4	BMP size in bits, B, KB, MB, GB
21	4	_IndexedBitmap: Indexed photo, correctly named
21a	4	Value between 8 and 32
21b	4	What changes did you notice in the image?
21c	4	Minimum number of bits to index photo
21d	4	How do you know what the minimum number of bits is?