Project 1: Information

Due: Thursday (beginning of class), 1 February 2024

Name(s): _____   _____

UVA Email ID(s): _____   _____

> For this assignment, you are expected to print out this PDF file and handwrite your answers on the paper, and submit your work as *stapled* papers. If you prefer to type your answers, you may either type answers in this overleaf template (you are not expected to be familiar with this yet, and we won't provide directions do to this for this assignment, but in a later assignment you will be expected to do this), or by editing the PDF file. It is not necessary or expected to typeset your responses for this assignment—handwriting is fine, so long as it is readable.

> **Collaboration Policy:** For this assignment, you may work alone or with **one** other student in the class that you chose. If you work with a partner, you and your partner should turn in one assignment with both of your names on it that reflects your work together. Both partners should understand and be able to explain everything you turn in.
>
> You may discuss the problems with anyone you want. You are permitted to use any resources you find for this assignment. You should write up your own solutions and understand everything in them, and submit only your own work. You should note in the below the people you collaborated with and any external resources you used. If you used any generative AI tools (e.g., chatGPT), please explain how you used them, and what your experience with them was like.

Collaborators and Resources:

Problem 1 *Analog vs. Digital*

For each of the following properties, describe one *analog* way of representing or measuring the property, and one *digital* way.

(a) time

　　Analog:

　　Digital:

(b) distance

　　Analog:

　　Digital:

(c) humor

　　Analog:

　　Digital:

Problem 2 *Number Representations*

(a) How would the decimal number 29 be represented in binary?

(b) What is the decimal value of $010101_2 + 101010_2 + 1_2$? (try to solve this without a lot of tedious calculation)

Hexadecimal number representation are base 16, using the symbols $\{0, 1, \ldots, 9, A, B, C, D, E, F\}$ to represent sixteen different values.

(c) How many binary digits (bits) does each hexadecimal symbol represent?

(d) What is the decimal value of the hexadecimal 22?

(e) What is the hexadecimal value of the decimal 255?

Moving Pictures

In Class 2, we discussed how audio goes from a recording studio through various computing devices and into your head, and the different analog and digital representations of the audio information along this path. For this problem and the next one, the goal is for you to think about the analogous path and representations for a picture. We'll start from an image you have on your computer or phone already (or if you don't have one, can get one).

Problem 3 *Representing an Image*

The first set of questions is about the stored image file itself. Your answers will depend on the specific image you selected, but should help you understand how that image is represented.

(a) What kind of file is the image? (You can probably determine this from the file extension. For example, if the filename ends in `.jpg` that indicates that is it a JPEG (which standard for "Joint Photographic Experts Group", but no one knows that unless they just looked it up) compressed image file.

(b) What is the size *in bits* of the file?

(c) What is the resolution (dimensions) of the image? (this should be an answer like 1280×720, giving the number of pixels in the representation of the image)

A common way to represent color in computers is RGB with 8-bit values giving the intensity of each of the three color channels (Red, Green, Blue). Each 8-bit value can be represented with two hexadecimal digits, so a color is represented by a sequence of six hexadecimal digits, preceded by a `#`. For example, the color `#FFFFFF` would correspond to maximum intensity of 255 (decimal) for each of Red, Green, and Blue, so will appear as white (which is hard to show on paper). The color `#00FF00` is **Lime**, `#FF6347` is Tomato, and (everyone's favorite web color) `#663399` is Rebecca Purple. (These are the standard Web color names.)

(d) How many different colors can be represented using RGB color?

(e) How many bits would it take to fully represent your image using 24-bit RGB color?

(f) What is the actual size of the image file in bits? If it is less than you calculated would be necessary for a full (uncompressed) representation, estimate the compression ratio.

Problem 4 *Transforming the Image*

This last problem is an open-ended one, for you to think about how the image got from the original source (i.e., if it is a photograph, the scene that was photographed) to what you perceive when you are looking at something on a display. Describe as many steps as you can, and how you think the image is likely to be represented at each step. This isn't meant to be a research problem — its okay to guess! For most images, a good guessed answer would include at least two different digital representations and at least two analog representations. You can express your answer as a mix of drawing and text, or any other way you want that conveys the path the image took and its different representations.

https://computingfor.github.io/ David Evans