Number Systems and Memory
Due: September 17, 2022

INSTRUCTIONS

This assignment explores the concept of data. What is data? As you tackle these questions, I want you to use the answers as a means that informs your views about the nature of data. Submit your answers in a single PDF document called **mini1.pdf**. The teaching assistants will hold office hours the week of the 17th.

You are expected to do all your work on your own. Plagiarism and cheating are a serious offence. You may ask classmates, the TAs and the professor clarification questions.

QUESTIONS

1. Given 8 random bits forming a byte, can you determine whether the byte represents an 8-bit integer or a character? Why?

2. Consider the following pseudo-assembler instructions:

```
load CPU_#, address

save CPU_#, address
```

Assume the following:

- `address` is an integer number greater than or equal to 0.
- The `load` instruction copies data pointed to by the `address` into the CPU.
- The `save` instruction copies the data from the CPU into the location pointed to by `address`.
- `CPU_#` represents the name of a single location inside the CPU, that can store a single value. This CPU has two storage locations for two distinct values: **CPU_0** and **CPU_1**.[1]

For example, `load CPU_0,100` means: load one byte from address 100 in RAM and store that byte inside the CPU at CPU index 0.

Assume that the string "ABC" is at address 109 in RAM:

a) Draw a table that represents how the string appears inside the RAM. The table must show the RAM addresses and data pairs correctly.
b) Using only the above two pseudo-instructions, write code that copies the string at address 109 to address 50 in RAM. We want the entire string to be present starting at address 50.

[1] Fun fact: look up the 6502 CPU. It also only had two general purpose storage locations, called registers. Which popular computers and video game consoles used this CPU? (just for fun, not part of the assignment).

NOTE: You only have these two instructions. If you want to repeat something, then you will have to write the instruction multiple times. Assume that we do not have a loop command.

3. The following questions relate to base conversion. Show your work:
   a) Convert 1023_{10} to Binary.
   b) What is the minimum number of bytes needed to store (a) in binary?
   c) Convert the binary result from (a) to Octal.
   d) Convert the 8-bit signed integer number 10110110_2 to decimal.
   e) Convert the decimal result from (d) to Hex.

4. Answer the following. Do not forget to show your work:
   a) Perform the following binary operation, assuming that the numbers are signed and that our resultant has a maximum of 8 bits:

$$00110110_2 + 01111001_2 - 00001100_2$$

   b) Was there an overflow, a signed overflow, or no overflow?
   Remember that a signed overflow occurs when a carry changes the sign bit. Remember that an overflow occurs when a carry goes beyond the available bits to store the result.

5. Answer the following. Do not forget to show your work:
   a) Convert 15.0625 into an IEEE single precision value.
   b) Convert 1.50625 into an IEEE double precision value.
   c) Add (a) and (b) together. What is the answer? Be clear on the operations performed.

WHAT TO HAND IN

A single PDF named **mini1.pdf** with the answers to the above questions. Submit this to the assignment box "mini 1" on myCourses.

HOW IT WILL BE GRADED

This assignment is worth 20 points.

Point Deductions:

- For not following submission instructions: -3 points
- For questions where your work must be shown, no points given for correct answers without work.

Points Awarded:

- Question 1: 2 points
- Question 2: (a) 2 points, (b) 2 points
- Question 3: (a) 1 point, (b) 1 point, (c) 1 point, (d) 1 point, (e) 1 point
- Question 4: (a) 2 points, (b) 1 point
- Question 5: (a) 2 points, (b) 2 points, (c) 2 points

TA GRADING INSTRUCTIONS

- 20% off per day late, max 3 late days.
- If the student submits a waiver, mark the assignment as 0 on myCourses but record the waiver event on the grading spreadsheet to average the students grades out of 5 assignments. If this student has used the waiver multiple times, then the grade is 0 for the assignment and do not record the waiver event.
- Remember to award grades proportionally to the students, this means if the student got a question half correct then they receive half of the points.
- Award the score to the student by comparing their work with the solution sheet.