AERO 552: Aerospace Information Systems
Homework 6

Out Monday, November 27th, 2023

Due on CANVAS Wednesday, December 6, 2023, **11:59pm**

Instructions

Your solution should be submitted:

- a file `hw7.pdf` containing your solution to the handwritten problems;
- file `realtime.cpp` containing your solution to Exercise 3.

For the coding exercises, remember the following guidelines:

- **Do not use any C++ library unless explicitly authorized, except `iostream`, `fstream`, `cmath`, and `string`**
- High-level discussion of problems and directions with other students is fine, but exchanging solutions or code is not. If in doubt, please ask. **If you discussed with another student, please indicate so explicitly in your homework, with their name.**
- All code from this homework will be graded on CAEN Linux using the `g++` compiler – please test it on CAEN prior to submission.
- Include your code along with the examples you have tested your code on. Examples would typically be in a function `main`. Please **thoroughly test your code**: part of your grade will be based on how well you have tested your code, including corner cases. Moreover, many errors can be caught with good testing.
- Please submit code that compiles (on Linux) **without any warning or error**, and runs right away. We will take off points if your code does not run or if it produces warnings.
- Be careful with pointer and memory management, and do not forget to `delete` your memory, even in your test cases. Points will be taken off for memory leaks (forgetting to `delete`).
- Please do not reference or utilize any online code.

Exercise 1 – Information theory (30 points)

1. The bit string "0101011" was received through a link utilizing a (7,4) Hamming Code. Decode the four source bits and indicate any necessary correction. Show your work.
2. Same question for the string "0100111"
3. Show an optimal Huffman code for the following ensemble; compute the average length of a transmitted character for the encoding and compare average length to the entropy H of the ensemble.

$$A_x = \{i, n, f, o, r, m, x, y, z\}$$
$$P_x = \{0.35, 0.2, 0.15, 0.08, 0.07, 0.05, 0.05, 0.03, 0.02\}$$

Exercise 2 – Exercise 1.8 p. 13 (30 points)

For the (7,4) Hamming code, show that a block decoding error (i.e. $\hat{s} \neq s$) will result whenever two of more bits are flipped in a single block. Note that in principle, there might be error patterns that, after decoding, led only to the corruption of the parity bits, with no source bits incorrectly decoded; that would still count as a decoding error.

Exercise 3: Real-time scheduling implementation (35 points)

In this exercise you will implement the two real-time scheduling algorithms we saw in class. You will be given a set of periodic tasks, each with a work length and a period (as integers), as well as a total time to do the scheduling for (also an integer). **Please show your algorithms working on a few convincing examples, that you will include.** You may choose your input data and data structures as you wish. Your output should be a clear print-out of the schedule on the command line, in a format of your choice.

1. Implement the Rate Monotonic (RM) schedule.
2. Implement the Earliest Deadline First (EDF) schedule.
3. Show how they differ on a few carefully chosen examples. Discuss.

Bookkeeping (5 points)

Indicate in a sentence or two:

1. how much time you spent on this homework;
2. how difficult you found it subjectively;
3. what you found to be the hardest part;
4. how deeply you feel you understand the material it covers (0%–100%).