CSCI 100: Information and Intelligence
Final Exam and Missed Class Assignment

Special Note

You must bring a copy of your midterm exam with you to the final exam in order to receive credit for it. If you fail to do so, it will not count towards your course grade, and everything else will be scaled up to account for that 30% of your course grade.

If your grade on the midterm would lower your course grade, it will not be used, so there is no reason not to bring your midterm exam with you to the final.

Introduction

As announced previously, the final exam will be cumulative, so be sure to review your copy of that exam to be sure you can answer all the questions correctly. (We went over the answers in class on October 23.) The list of topics for the midterm are repeated at the end of this document for your reference. I can send you a copy of that exam if you cannot locate yours.

The "Missed Class" assignment for the course is to write a 3-5 page essay in which you explain how Information Theory, Artificial Intelligence, Computer Algorithms (Code), and Probability Theory are related to each other. Be sure you have studied all the material on the Missed Class Assignment page before you start. If you had time you could write a book about such a broad range of topics, so here are some guidelines for how to approach this essay:

- Assume the reader is a normally intelligent college freshman who has not taken this course. The goal of the essay is to explain the topics and their relationships to that audience, not to a Computer Science professor, an English professor, or an idiot.
- Before you start writing, create an outline for yourself of how you will structure your essay. In 3 pages, you have room for only a dozen or so paragraphs, so think about the sequence of paragraphs. Do they have a logical sequence? Do they fall into natural groups? Remember, each paragraph should have a topic, and typically each paragraph will normally have more than one sentence.
- Grammar, spelling, punctuation, and proper use of a word processor, all count. Your writing style should be formal, not casual. This is a college essay, not Facebook.
- Be sure your essay has a title (more meaningful than "Missed Class Assignment!") and your name at the beginning. Use heading styles for sections.
- In order to show how the topics relate to each other, you will need to give a brief explanation of each topic, and include some relevant definitions. Provide transitions in the text so the essay "holds together," and is not just a list of unrelated paragraphs.

- Use your own words, but you can include quotes from, or paraphrase ideas from, other sources of information (textbooks, web pages, newspaper articles, etc.). But be sure you put quotation marks around direct quotations and cite the source in either case. Plagiarism will give you a failing grade in the course.

Questions

In addition to the essay, you are to hand in the answers to the following questions. Both parts of the assignment are due by midnight of December 20, but you should be sure to work on the answers to these questions before the exam: they constitute part of your review topics for the exam. (The material from the midterm exam, class notes, and homework assignments 6, 7, and 8 are the remainder of the review topics.) You can either bring handwritten answers to these questions to the exam or submit them in a word processing document.

1. What does a *delay()* statement do in Teagueduino? What does the number inside the parentheses mean?
2. A signal has a period of 5 msec. What is the frequency?
3. A signal has a frequency of 500 KHz. What is the period?
4. Draw a waveform of a 20 Hz binary waveform with a pulse width of 10 msec.
5. If you were to sample the previous waveform at random times, what is the probability you would sample it when the pulse is on?
6. If I flip a fair coin 5 times, what is the probability it will come up heads each time?
7. What is the probability it will come up heads 4 times?
8. What does an *if* statement do in Teagueduino? What goes inside the parentheses?
9. If the bits of an n-bit binary counter are numbered 0, 1, ... n-1 *from right to left*, what information do you need to determine the next state of bit #3?
10. What will be the *next state* of bit 0?
11. What will be the *period* of a 3-bit binary counter if the frequency of the rightmost bit is 1Hz?
12. Given the table of English Digram Frequencies what is the probability of the letter 'E'?
13. What is the probability of the sequence 'ES'? (*Hint: what portion of all the digrams in the table are ES?*)
14. What is the probability of S given E, that is: *p*(S|E)? (*Hint: what portion of the digrams in row E are ES?*)
15. What is a *variable* in Teagueduino, and how do variables relate to the *state* of a binary counter?
16. What question does the *Turing Test* attempt to answer?
17. Who is it named for, what was his area of work, when did he live, and how did he die?
18. Is it a good way to define intelligence? Defend your answer.
19. How many bits would be needed to implement a modulo-8 counter?
20. What is *Artificial Intelligence*, and what is an *Intelligent Agent*?

Word Processing: appearance *vs.* structure (styles)

Information Theory

- Who was Claude Shannon? When and where did he work when he developed the principles of Information Theory? How do those circumstances relate to his use of the terms "channel" and "message?"
- How did Shannon propose to measure information?
- When was the binary number system developed?
- Who coined the term "bit," and what words does it stand for?
- In what situations would you do a *binary search*? How do you do a binary search?
- How does binary search relate to Shannon's proposed way of measuring information?
- Under what circumstances do fractional numbers of bits occur in Information Theory? In the real world? Trick question: how do computers deal with fractional numbers of bits?
- How many bits of information are needed to determine which face of a die is "up" if there is no trick? How many bits are needed with the trick die used in class? Explain the difference.
- What does the phrase, "a logarithm is an exponent" mean?
- What shortcut can you use to multiply or divide two numbers that are written in exponential notation, if the bases are the same? Give an example.

Non-decimal numbers

- What is the *radix* for binary numbers? Octal? Decimal? Hexadecimal?
- How many bits does the hexadecimal number CAFEBABE represent? How many bytes?
- Convert $CAFEBABE_{16}$ to binary.
- Which programming language uses $CAFEBABE_{16}$ as an internal "signature" in its code? (*Hint: what programming language is named for a beverage that might be served at a café?*)
- Convert $123 \frac{123}{256}$ to binary.
- Convert $0111\ 1011.0111\ 1011_2$ to decimal.

Waveforms

- What is the X axis of a waveform graph?
- What is the name of the instrument that displays voltage waveforms?
- What is a *pulse*? What is a waveform *cycle*? How are they related?
- What is the relationship among the *speed, frequency,* and *rate* of a waveform?
- What is the name of the unit of measure for frequency, and what is its definition?
- What is a *digital* waveform?
- What is an *analog* waveform? Why is it called "analog?"
- What is the *period* of a waveform, and how is it related to frequency?

- What is the unit of measure for the period of a waveform?
- Explain how *frequency modulation, amplitude modulation,* and *pulse width modulation* can be used to encode information.

Units of Measure

- What do the prefixes K, M, and G stand for, and how do they relate to exponents? Answer for both base 10 and base 2.
- How many bits in a byte?
- Which is larger, 1 Kb or 1 KB, and by how much?
- What is *bandwidth*, and what is the unit of measure?
- How does bandwidth relate to Shannon's definition of information?
- What do the prefixes *m, μ,* and *n* stand for, and how do they relate to decimal exponents?
- Which prefix would be used for measuring *frequency*: K or *m*? Which for *period?* Likewise for M, *μ*, G, and *n*.

Encoding Techniques

- Make up two different binary codes for representing the days of the week. Use the minimum number of bits possible for each *code point*.
- How many bits does the ASCII code use to represent characters?
- What does the acronym ASCII stand for, and what is significant about the A and the first I?
- How many bits does the ISO-Latin-1 code use to represent characters? What is the relationship between ASCII and ISO-Latin-1. What does ISO stand for, and what is significant about the I?
- How many bits does Unicode use to represent characters?
- How many different characters can be represented using ASCII, ISO-Latin-1, and Unicode?
- How many symbols do African drumming languages use to encode information? Why are messages sent repeatedly using drumming?
- How many symbols does Morse Code use to represent information? Is it a binary code? Are all characters represented using the same number of symbols? Why, and what does the number of E's in a printer's box of type have to do with this question?
- How is auditory information transmitted through the air? What is the device called that turns auditory signals into electrical ones? What is an ADC? How do sampling rate and bits per sample relate to the process of digitizing auditory information? How many bits are needed to encode an auditory signal?
- Which would be harder to crack: a password that can be any length and made up of any characters, or one that must be between 16 and 18 characters long including exactly one digit and one uppercase letter with no punctuation symbols allowed? Why?

Teagueduino

- How many inputs? How many bits per input? How many outputs? How many bits per output. How much information can come into the device at a time? How much information can be output at a time?
- What are the waveform characteristics of DIG, Servo, PWM, and Sound outputs?
- What are the two sections of code?
- What does the *delay* statement do?
- What does an *if* statement do? Be general; give a specific example.
- What is a nested *if* statement?