CMPSCI 145
Spring 2021
Representing, Storing, and Retrieving Information

Professor William T. Verts

Class:

> Monday, Wednesday, Friday 11:15AM–12:05PM Eastern Time. Zoom links will be emailed via SPIRE the day before. Zoom recordings of the lectures will be posted the same day.

Office Hours and Email:

> M/W/F 11:15-12:00 & by appointment. Zoom links will be emailed via SPIRE the day before.
> I am retired and will not be participating in UMass activities on Tu/Th, but will check email.
> `verts@cs.umass.edu`   Personal, for asking questions.   Put CMPSCI 119 in the subject line.
> `literacy@cs.umass.edu`   For submitting on-line materials.   Put CMPSCI 145 in the subject line.
> I read all email daily, but do not expect a speedy reply. I might not reply at all if the question is something I can address in class. Do NOT email attachments to me; they will be deleted. Do not call me at home.

Books:

> ***Computer Science Companion***, 5TH Edition, 2020 Printing, ISBN 9781792446696, $28 (paper) or $15 (digital, 180 day subscription), by me. We will get all other reference materials from the Web itself. The ***Computer Science Companion*** is a required text for COMPSCI 119, 120, and 145.

> ***Representing, Storing, and Retrieving Information***, 4TH Edition, ©2009, William T. Verts. This is a free text stored on Moodle as an encrypted `.PDF` file. Download to your desktop.

Web: `http://www.cs.umass.edu/~verts`
> `http://www.cs.umass.edu/~verts/cmpsci145/cmpsci145.html`
> `http://www.cs.umass.edu/~verts/cmpsci145/quizzes/quizzes.html`

Social Media:

> Please do not "friend" me on Facebook, Linked-In, or other social networks. I reserve Facebook for relatives, hiking buddies, and friends from high-school.

Course Scoring (percentages may change according to number and type of assignment):

> Midterm 1   15% late February or early March, in-class. Open book, open notes.
> Midterm 2   15% early April, in-class. Open book, open notes.
> Final Exam   20% Final's Week in May. Open book, open notes, with a take-home portion.
> Homework   50% (formally assigned homework, occasional projects)

Letter grades will be assigned according to final computed course score:

> A ≥ 90%, A- ≥ 88%, B+ ≥ 86%, B ≥ 80%, B- ≥ 78%, C+ ≥ 76%, C ≥ 64%, C- ≥ 62%, D+ ≥ 60%, D ≥ 50%, F < 50%. Missing either of the midterms, or the final exam, incurs an automatic F for the course. Fractional final course scores are ⌈ceilinged⌉ to the nearest integer.

> <u>**Do not**</u> ask for extra work after the end of the semester to boost an undesirable grade. It is unfair to other students in the class and I never grant such requests.

> Please contact me directly if you have any concerns about the running of the course, the TAs, grading, etc.

Course Expectations:

COMPSCI 145 is an unusual course. Few students will have any real notion of what to expect. Whatever your preconceived notions are about this course, I can guarantee that you'll be surprised! This course is much more "mathy" and less project-based than most of the courses I teach. We will do in-class activities, discussions, and problem-solving, in addition to the more traditional lectures. There will be a fair amount of paper-based homework. My *official* goals for this course are to teach you "how things work" with respect to information handling: How did we represent information before the advent of modern computers? What are the differences between analog computing and digital computing? How do modern computers represent numbers, characters, equations, pictures, and sounds? How does compression work? What are some of the techniques used in encryption, and why do we use it? How can we send a digital image from a space probe around Saturn through a horribly noisy environment to Earth without data loss? What are the different ways that people can solve each of these problems, and what are the advantages and disadvantages of each approach? My more *unofficial* goals are to have you become aware of the engineering decisions that surround us every day, and to have you ask "why?" about each one. I want you to be able to look at *any* artifact, a computer program or something in the real world, and ask yourself what are the compromises that went into crafting those artifacts? If you can see with those new eyes, we've done our job.

Course Outline:

Here is a general sense of the topics we will cover:

1. Analog vs. Digital (what's the difference and why do we care?)
2. Basic mechanics (sticks, gears, levers, hydraulics)
3. Analog devices that are mechanical (slide rules, gear trains, old fire control computers, generation loss)
4. Basic Electricity (Ohm's Law, resistor networks)
5. Analog devices that are electrical (vacuum tubes, analog functional elements, ENIAC)
6. Digital devices that are mechanical (the Comptometer and the notion of 9's and 10's complement)
7. Digital functional elements (truth tables and gates)
8. Quick introduction to binary and binary addition
9. Gate Circuits (adders, shift registers, counters, the notion of clock speed)
10. Unsigned vs. signed binary integers (1's vs. 2's complement, BCD, XS3, Gray code)
11. Rational, fixed-point, and floating-point numbers (round-off errors, interval arithmetic, UNUMs)
12. Symbolic computation (binary trees, with an aside on machine language and compilers)
13. Parametric equations (linear, quadratic, cubic, Bézier, Spline), Lagrange interpolation
14. Computational geometry and computer graphics (from pixels to ray-tracing)
15. Representations of audio and video
16. Searching and sorting (linear vs. binary search, self-organizing lists, trees, hash tables, SoundEx, big-O)
17. Databases (linear access, random access, hierarchical access)
18. Data transmission (Serial vs. Parallel protocols)
19. Information theory, error detection and correction (parity, cyclic redundancy checks, Hamming distance)
20. Compression (run-length encoding, Huffman coding, delta modulation, LZW, lossy vs. lossless)
21. Coding (Morse, QR Codes, Data Matrix, Bar Codes, Nerds in the Woods)
22. Encryption (Caesar Cipher, permutations, Enigma, RSA, single key vs. public key, steganography)

Final Notes:

1. **DO YOUR OWN WORK, INCLUDING HOMEWORK AND LAB WORK.** You may discuss homework and lab assignments with other students, but you may not share files or code. Upon discovery of duplication, I will contact you for a conference, as required in the guidelines set out by the University of Massachusetts Academic Honesty Policy, and we will resolve the issue according to those guidelines. See:

   http://www.umass.edu/dean_students/academic_policy/
   https://www.umass.edu/honesty/
   https://people.cs.umass.edu/~verts/class_documents/AcademicHonestyPolicy.html

2. Students who are registered through Disability Services should arrange for accommodations as soon as possible. See:
   http://www.umass.edu/disability/
   https://people.cs.umass.edu/~verts/class_documents/DisabilityStatement.html