The Hardware/Software Interface
CSE 351 Winter 2024

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Will Robertson

http://xkcd.com/676/
Quarter Specifics
Course Staff

❖ Instructor: just call me Justin
  ▪ CSE Associate Teaching Professor
  ▪ Raising a toddler takes up energy and dictates my schedule

❖ TAs:

❖ More than anything, we want you to feel...
  ✓ Comfortable and welcome in this space
  ✓ Able to learn and succeed in this course
  ✓ Comfortable reaching out if you need help or want change
Bookmarks

❖ Website:  https://courses.cs.washington.edu/courses/cse351/24wi/
  ▪ Schedule, policies, materials, tutorials, assignment specs, etc.

❖ Ed Course:  https://edstem.org/us/courses/50549/
  ▪ Discussion: announcements, ask and answer questions
  ▪ Lessons: lessons, practice problems, homework

❖ Linked from website and Ed
  ▪ Canvas: surveys, grade book, Zoom links
  ▪ Gradescope: lab submissions, take-home exams
  ▪ Panopto: lecture recordings
Grading

- **Lesson Problems:** 6%
  - Can reveal solution after one attempt (completion)

- **Homework:** 20% total
  - Unlimited submission attempts (autograded correctness)

- **Labs:** 40% total
  - Last submission graded (correctness)

- **Exams:** Midterm (16%) and Final (16)
  - Take-home; individual, but some discussion permitted

- **EPA:** Effort, Participation, and Altruism (2%)
Support Hours

- Check Weekly Calendar on website for scheduled support hours:
  - In-person or virtual, but NOT hybrid
  - Zoom meeting links found in Zoom tab within Canvas

- All support hours will use a Google Sheets queue:
  - Fill out first 3 columns to enter queue:

- We encourage you to chat with other students if the TAs are busy!
In-Person Support Hours

- Allen 3rd & 4th floor breakouts
  - Up the stairs in the CSE Atrium (Allen Center, not Gates)

- The open areas with the whiteboard walls are the breakouts!
Lecture Polls and Discussions

- Increase learning, test your understanding, increase student interactions, makes the class more engaging and fun
  - Lot of research supports its effectiveness:

- Polls on technical material will be multiple-choice and short answer
  - You haven’t mastered the material yet; mistakes are part of the process!

- Discussion questions will be more open-ended
  - Be respectful of others’ opinions and experiences

- Respond on Lecture Ed lesson for credit (extra late day tokens) and we will use *random call* to solicit live responses from audience
  - Don’t need to be correct, just want the feedback of what was discussed
To-Do List

❖ Admin
  ▪ Explore/read the course website *thoroughly*, especially the syllabus
  ▪ Check that you can access Ed Discussion & Lessons
  ▪ Get your machine set up to access the CSE Linux environment *(attu or cancun)* as soon as possible
  ▪ Optionally, sign up for CSE 391: System and Software Tools

❖ Assignments
  ▪ Pre-Course Survey and hw0 due Friday (1/5)
  ▪ HW1 and Lab 0 due Monday (1/8)
  ▪ Lessons quiz questions due 11:59 pm *after* the associated lecture
Binary and Numerical Representation
Lesson Summary

❖ Humans think about numbers in decimal; computers think about numbers in binary
  ▪ Base conversion: digit $d$ in position $i$ in base $b$ has a decimal value of $d \times b^i$
    • Changing bases does not change the value; just a different representation
  ▪ Hexadecimal (base 16, prefix 0x) is more human-readable than binary (base 2, prefix 0b)
  ▪ Unit of data in a computer is 1 byte = 8 bits = 2 hex digits

❖ Binary encoding can represent anything!
  ▪ Computer/program needs to know how to interpret the bits

<table>
<thead>
<tr>
<th>Base 10</th>
<th>Base 2</th>
<th>Base 16</th>
</tr>
</thead>
<tbody>
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<td>0x0</td>
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<td>0b1110</td>
<td>0xE</td>
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<tr>
<td>15</td>
<td>0b1111</td>
<td>0xF</td>
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</tbody>
</table>
Lesson Q&A

❖ Learning Objectives:
  ▪ Convert between binary, decimal, and hexadecimal number representations.
  ▪ Given an encoding scheme, decode and encode binary to/from its intended representation.
  ▪ Identify limitations of given encoding schemes.

❖ What lingering questions do you have from the lesson?
  ▪ Introduce yourself to your neighbors and chat about the lesson for a few minutes to come up with questions
Binary and Numerical Representation – Practice
Polling Questions

❖ What is the decimal value of the numeral $107_8$?
A. 71  
B. 87  
C. 107  
D. 568

❖ What is the decimal number 108 in hex?
A. 0x6C  
B. 0xA8  
C. 0x108  
D. 0x612

❖ Represent 0b100110110101101 in hex.

❖ Represent 0x3C9 in binary.
Homework Setup

- Binary alphabet using five 4-bit numbers stacked on top of each other:
  
  \[
  \begin{array}{cccc}
  0 & 1 & 1 & 0 \\
  1 & 0 & 0 & 1 \\
  \end{array}
  \]

  □ □ □ □

  □ □ □ □ □

  0x69F99 → 1 1 1 1 → □ □ □ □ □

- What string of 5 hex digits represents a “C”?
Binary and Numerical Representation – Context
Why Base 2?

❖ Electronic implementation
  ▪ Easy to store with bi-stable elements
  ▪ Reliably transmitted on noisy and inaccurate wires

❖ Other bases possible, but not yet viable:
  ▪ DNA data storage (base 4: A, C, G, T) is hot @UW
  ▪ Quantum computing
Binary Encoding – Colors

❖ RGB – Red, Green, Blue
   - Additive color model (light): byte (8 bits) for each color
   - Commonly seen in hex (in HTML, photo editing, etc.)
   - Examples: Blue→0x0000FF, Gold→0xFFD700, White→0xFFFFFF, Deep Pink→0xFF1493
Binary Encoding – Characters/Text

- ASCII Encoding (www.asciitable.com)
  - American Standard Code for Information Interchange

<table>
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<tr>
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<th>Hx</th>
<th>Oct</th>
<th>Char</th>
<th>Dec</th>
<th>Hx</th>
<th>Oct</th>
<th>Html</th>
<th>Chr</th>
<th>Dec</th>
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<th>Chr</th>
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<td>h</td>
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<td>F</td>
<td>15</td>
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<td>89</td>
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<td>$#83$</td>
<td>i</td>
<td>127</td>
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</table>

What's Missing?
Binary Encoding – Characters/Text

❖ ASCII Encoding (www.asciiitable.com)
  ▪ American Standard Code for Information Interchange

❖ Created in 1963
  ▪ Memory was expensive, 32KB in brand new machines
  ▪ Economic incentive to use fewer bits for encoding

❖ Design Goals:
  ▪ Represent everything on an American typewriter as efficiently as possible
  ▪ Organize similar characters together
    • Numbers, uppercase, lowercase, then other stuff
Binary Encoding – Unicode & Emoji

❖ Unicode Standard is managed by the Unicode Consortium
  ▪ “Universal language” that uses 1-4 bytes to represent a much larger range of characters/languages, including emoji
  ▪ Adds new emojis every year, though adoption often lags: 🪖 (ninja)
    • [https://emojipedia.org/new/](https://emojipedia.org/new/)

❖ Emojipedia demo: [http://www.emojipedia.org](http://www.emojipedia.org)
  ▪ Taco: 🌮 (added 2015)
  ▪ Code points: U+1F32E
  ▪ Display (as of 2023):
Discussion Question

❖ Discuss the following question(s) in groups of 3-4 students
  ▪ I will call on a few groups afterwards so please be prepared to share out
  ▪ Be respectful of others’ opinions and experiences

❖ The Unicode Consortium publicly solicits proposals from the public for new emoji to add to future standards
  ▪ What do you think some of the decision factors are (or should be) in how many and which ones to add?
  ▪ Voting is done by a combination of paid members consisting of companies, institutions, and individuals – how do you feel about who has control and how they gained that control?
  • [https://home.unicode.org/membership/members/](https://home.unicode.org/membership/members/)
Group Work Time

❖ During this time, you are encouraged to work on the following:
  1) If desired, continue your discussion
  2) Work on the homework problems
  3) Work on the lab (if applicable)

❖ Resources:
  ▪ You can revisit the lesson material
  ▪ Work together in groups and help each other out
  ▪ Course staff will circle around to provide support