§8.2-8.4: Data Storage

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CMPT14x
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Using bases in Python

- Python has special notation for expressing integer literals in hexadecimal and octal:

  - Hexadecimal: prefix "0x"

    hexNum = 0xBEEF   # 48879

  - Octal: prefix "0"

    octNum = 0115   # $1(8^2)$ + $1(8^1)$ + $5(8^0)$ = 77

- Convert into strings with hexadecimal/octal notation:

  hexStr = hex(48879)   # '0xbeef'

  octStr = oct(77)   # '0115'

Bits, bytes, nibbles, words

- One hexadecimal digit can be represented by four bits: one nibble

- Two nibbles (eight bits) is called a byte
  - One byte can be used to store one CHAR

- A group of bytes can be used to represent one datum: this is called a word
  - Pentium CPUs generally use 4-byte words (32 bits)
  - Newer CPUs can use 8-byte words (64 bits)
  - Word is the smallest unit of data the machine can store or retrieve

Accessing memory

- A computer's main memory (generally, RAM) stores everything it needs to do its current tasks

- A location within memory is uniquely identified by its address

  - Most modern CPUs use 32-bit words to store memory addresses

  - This means there is a maximum of 2^{32} unique memory addresses (the address space)

  - If each location stores one byte of data, then there is 2^{32} bytes = 4GB of addressable memory

Units of measure

- SI abbreviations:
  - K = kilo = 1,000
  - M = mega = 1,000,000
  - G = giga = 1,000,000,000
- When working with binary data:
  - KB = kilobyte = 1,024 bytes = 2^{10} bytes
  - MB = megabyte = 1,024,576 = 2^{20} bytes
  - GB = gigabyte = 1,073,741,824 = 2^{30} bytes
  - But hard drive manufacturers use SI abbrevs

Units of measure, cont.

- Kilobytes vs. kilobits:
  - KB = kilobyte = 1,024 bytes = 8192 bits
  - Kb = kilobit = 1,024 bits
  - RAM chip manufacturers often use kilobits
- Also, in SI abbreviations,
  - M = mega = 10^6: e.g., megawatt = 10^6 watt
  - m = milli = 10^{-3}: e.g., milliwatt = 10^{-3} watt
- But not everyone is consistent, so be careful

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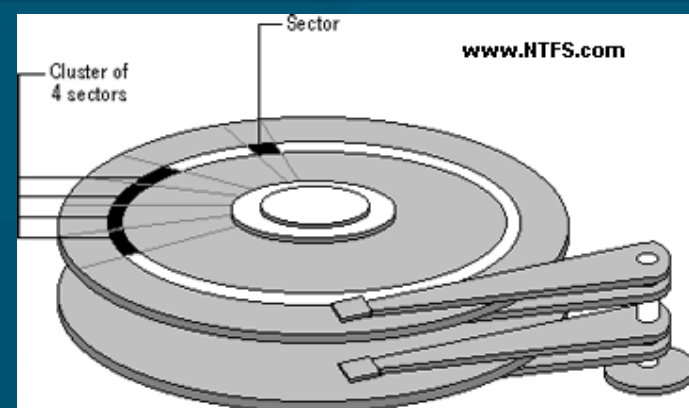
Storage

- A page of memory is generally 256 bytes

- A sector is a unit of disk storage, also commonly 256 bytes (but sometimes 512 bytes)

- A block of disk storage is usually 512 bytes

- Hard disks are made up of platters, accessed by magnetic heads on movable arms

- The platters have concentric tracks that (across all heads) make up cylinders

- Hard drive geometry is often expressed in C/H/S: # cylinders / # heads / # sectors per track

Summary of today (§8.0-8.3)

- Number bases:
  - Binary
  - Hexadecimal (0xBEEF)
  - Octal (0115)
- Units of measure of memory:
  - Bits, nibbles, bytes, words, pages
- Units of measure for hard disks:
  - C/H/S geometry
- SI units vs binary units, KB vs. Kb, etc.

TODO items

- Register for CMPT145 if you haven't already

- HW06 due Mon:

- Lab06 due next Wed: ch7 (choose one):
  - # 22: word search game
  - # 32: graphical analysis of pseudorandom
  - # 37: matrix library
  - # 43: encryption algorithms