HPC Fundamentals
Binary Numerical System

Robert Whitten Jr

Numbering systems

- The system we use to count
  - unary numeral system
    - tally marks (3 = |||)
    - sign-value notation (1s = /, 10s=+) 23 = ++///
      - Ancient Egypt and Rome used this type
  - positional system
    - Uses a base raised to some power ($base^{exp}$)
- Several positional systems exist
  - Decimal
  - Binary
  - Octal
  - Hexadecimal

Oak Ridge National Laboratory

Positional systems

- Uses a base and an exponent
  - $base^{exp}$
  - base & exp are typically an integer (0, 1, 2, etc.)
    - ex: 10^2, 2^3, 16^1, 8^0
      - note: $base^0 = 1$ (because mathematicians say so)
- Base-10 (decimal)
  - Most frequently used (humans have 10 fingers)
  - 8, 24, 205, 1254, 35343, 543636
- Base-2 (binary)
  - What computers use
  - 0, 1, 01, 010, 01010101010101110
- Base-16 (hexadecimal), Base-8 (octal)

Oak Ridge National Laboratory

Positional systems

- Base-10 (decimal)

834=

0	0	0	8	3	4
100000s	10000s	1000s	100s	10s	1s
10^5	10^4	10^3	10^2	10^1	10^0

Oak Ridge National Laboratory

Positional systems

- Base-10 (decimal)

834=

0	0	0	8	3	4
100000s	10000s	1000s	100s	10s	1s
10^5	10^4	10^3	10^2	10^1	10^0

$$= \quad 0*10^5 + 0*10^4 + 0*10^3 + 8*10^2 + 3*10^1 + 4*10^0$$

Oak Ridge National Laboratory

Positional systems

- Base-10 (decimal)

834=

0	0	0	8	3	4
100000s	10000s	1000s	100s	10s	1s
10^5	10^4	10^3	10^2	10^1	10^0

$$= 0*10^5 + 0*10^4 + 0*10^3 + 8*10^2 + 3*10^1 + 4*10^0$$

$$= 0 + 0 + 0 + 800 + 30 + 4$$

$$= 834$$

Oak Ridge National Laboratory

Positional systems

- Base-2 (binary)

13=

1101=

0	0	1	1	0	1
32s	16s	8s	4s	2s	1s
2^5	2^4	2^3	2^2	2^1	2^0

$$= 0*2^5 + 0*2^4 + 1*2^3 + 1*2^2 + 0*2^1 + 1*2^0$$

$$= 0 + 0 + 8 + 4 + 0 + 1$$

$$= 13$$

Oak Ridge National Laboratory

Questions?

http://www.olcf.ornl.gov