

Lecture 3 - Units and Error

- I. Units - Excel on Units
- II. DataTypes
- III. Finite Precision Errors - Python Activity

± Units

* units are a std reference.
- length, time, mass, temperature,

ft
m

* There are 2 main systems:

* SI

* English

* $7\text{ N} = ?\text{ lbf}$

$$7\text{ N} \times \frac{1\text{ lbf}}{4.448\text{ N}} = 1.574\text{ lbf}$$

* "Dimensional Homogeneity": All equations must have the same units on both sides

$$F = m \cdot a$$

↑ ↑
N $\text{kg} \frac{\text{m}}{\text{s}^2} = \text{N}$

* Computational Tools w/ units - Tips

- pick a single unit system - SI or Eng
- Convert @ beg. i. end of your code / sheet.

m
T
t

- use either kg, m, s or slug, ft, s

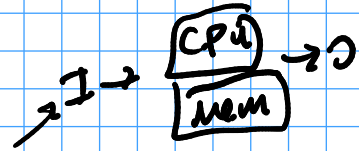
$$1N = 1 \frac{kg \cdot m}{s^2}$$

$$1 lbf = 1 slug \frac{ft}{s^2}$$

- use absolute temp scale (K, R)

Activity Unit conversions in Excel.

II. Data Types



* variables must be stored in memory in a computer

variable
4 $\begin{matrix} \uparrow \\ 101 \end{matrix}$

- Boolean variables (T/F)
- Integers (1, 2, 3, or -4)
- Strings/chars ('a', 'book', '123')
- Decimal, aka "float": 3.14159

(aside) 1 bit = a single 1 or 0
 1 byte = 8 bits
 1 kilobyte = 1000 bytes
 1 megabyte = 10^6 bytes

GB = 10^9
 TB = 10^{12}
 PB = 10^{15}

Boolean

0 = False
 1 = True
 } 1 bit

Integers

$$\begin{matrix} & 1 & 0 & 1 & 1 \\ & \uparrow & \uparrow & \uparrow & \uparrow \\ 2^3 & 2^2 & 2^1 & 2^0 \end{matrix} = 8 + 0 + 2 + 1 = 11$$

2 bytes $\Rightarrow \approx 64K$
 1 bit = +/-

-32,768 $\rightarrow$ 32,767

chars/ strings

(.66)

Table: Ascii Table (128 #'s: 1 byte) → unicode (16 bytes?)

$$0100 \ 0001 = A$$
$$0100 \vee 010 = 0$$

string: sequencia de chars: "AB"

Stochastics / decimals ("scientific notation")

$$\pi = 3.14159 \dots$$

(+) - bit sign
 0.314159 $\times 10^{-1}$
 mantissa exponent.
 binary $\leftrightarrow$ decimal

"float" : 4 bytes

8 decimals of precision

exponent ± 37

 6.02×10^{23} ✓
$$6.02 \times 10^{23} \times$$

"double" = 2x bytes of a float

- 16 animals

± 308 exponent.

III. Finite Precision Errors

* consequences of only having 8 or 16 decimal points

5 examples

- Truncation error: $\frac{2}{3} = 0.\overline{6}$
 $= 0.666 \times 10^0$

* Underflow error: $5.4 \times 10^{-400} \approx 0$

• overflow : $3.8 \times 10^{410} \approx \infty$

• Round-off error :

addition =

$$\begin{array}{r} 0.4300 \times 10^4 \\ 0.1 \times 10^0 \end{array} \rightarrow \begin{array}{r} 0.4300 \times 10^4 \\ 0.0001 \times 10^4 \\ \hline 0.4301 \times 10^4 \end{array}$$

subtraction:

$$\begin{array}{r} 0.4300 \times 10^4 \\ - 0.4290 \times 10^4 \\ \hline 0.0010 \times 10^4 \end{array} \rightarrow 0.10 \begin{array}{l} ?? \\ \boxed{} \end{array} \times 10^2$$

made up

Activity

Data Types: Finite Precision in Python