AE 320/706: Computational Fluid Dynamics

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Recap

- What do we mean by "solve"?
- The notion of a residue
- Solutions are in the form of functions
- Representing functions on the computer
- Closed form/analytic solutions
  - No analytic solution sometimes!

Recap

- Represent mathematical entities on the computer
- Binary
- Nibble and the 4 bit computer
- Countable vs. uncountable
- Rationals vs. irrationals

Recap

- Fixed point arithmetic
- Catastrophic cancellation
- Base 10, cannot represent even fractions correctly

Recap

- Floating Point representation.
- IEEE754 representation
  - Sign(1), exponent (8), matissa (23)
  - Big endian vs little endian
  - The hidden bit gives us effectively 24 places.
  - Epsilon of the machine.
  - Using hidden bit -> "normalized" number

Tutorial

- What is 27 in binary?
- What is 0.1 in binary?
- What is 1.01325e5 in binary?

More on representation on the computer

- Why do we need an IEEE standard?

Representation

- $\pm d_0.d_1d_2...d_{p-1} \times \beta^e$
- How do you represent zero?

Errors

- Integer overflow
- Roundoff
- Units in the last place (ulps)
- 0.0314 and 3.12×10^{-2}
- 2 ulps
- $|d.d...d - z/\beta^e|\beta^{p-1}$
- Relative error

Floating point

- Finite mantissa
- Finite exponent
- Take an example, $\beta = 10, p = 3$
- $2.15 \times 10^{12} - 1.25 \times 10^{-5}$

Guard digits

- Consider 10.1 - 9.93
- Calculate the value using the fixed mantissa
- Compute the result?
- Extra-guard digit
- Truncate smaller number to p+1 digits
- Then round result to p digits

Exercise

- Consider 110 - 8.59 with and without a guard digit

Special numbers

- How do you represent zero?
- Infinity?
- NaNs?
- Denormalized numbers

Special numbers

Exponent	Fraction	Value
$e_{min} - 1$	$f = 0$	± 0
$e_{min} - 1$	$f \neq 0$	$0.f \times 2^{e_{min}}$
$e_{max} + 1$	$f = 0$	∞
$e_{max} + 1$	$f \neq 0$	NaN