FLOATING POINT PROBLEMS
PROBLEMS SOLVED, OR AT THE VERY LEAST POSTPONED – IBM 7094

- Floating point hardware standardization is avoided for as long as possible
  - Companies start coming up with their own floating point hardware, leading to tons of variance
    - LINPACK and EISPACK packages, written with government subsidy to be portable, cost over $100 per line of code, partly because of porting complications
  - “Is accuracy really that important?”
    - Bits of floating point accuracy at high precision are often sacrificed for the sake of convenience
    - This is fine, mostly because high precision isn’t needed at this point in time
- Little tricks
  - Learning these shortcomings, and weird methods to fix them, was just considered part of being a programmer
THE PROBLEMS ARE NO LONGER POSTPONED, THEY ARE HERE – IBM S/360

• IBM introduces a new computer for all markets, with more memory and more power
• More memory means more precision, old software is ported to use double precision
• Double precision had other issues
  • No guard bit;
    • $1.0 \times x = x$ is false, because the last 4 bits are dropped
  • All these rules and theorem about round-off error, are lost with this capability for wider range and precision
• Everything is a mess. Development is super expensive, and everyone is upset.
AN ENTIRELY DIFFERENT SET OF EQUALLY CATASTROPHIC PROBLEMS – CRAY COMPUTERS

- Cray Computers are fast. That’s their thing.
- How do you get speed? You take some shortcuts.
  - Rounding bits are left out
  - AND gates for things like exponent checking are routed out
  - Adder and multiplier use different size operations (i.e. comparison check)
- If \( x == 0.0 \) \( y=17.0 \) else \( y=z/x \)
- If \( 1.0 * x == 0.0 \) \( y=17.0 \) else \( y=z/x \)
IEEE SLOWLY SAVES THE DAY

Thanks to Robert G. Stewart
FLOATING POINT TIMELINE

1970s
- IEEE FP standard started
- Intel plans leaked
- 20% to 500% performance increase

1980
- Intel releases 8087 chip

1985
- IEEE Standard 745 for Binary Floating Point was made official
- The standard was similar to Intel’s implementation.
INTEL 8087 CHIP

• Some Specs
  • Could perform 50,000 FLOPS using around 2.4watts
  • Max clock speed was 4MHz to 10 MHz
• First x87 floating-point coprocessor chip (for the 8086 series)
  • A coprocessor is a chip that externally performs a specific function. (Similar to modern graphics cards.)
• IBM included a coprocessor socket on their PC which increased the demand for 8087 chips.
PROBLEMS WITH INTEL AND IEEE 754

- 8087 chip could only be passed information through ram.
- Every 8087 instruction needed to be followed by the “FWAIT” instruction.
- The Intel 8087 chip doesn’t implement the exact IEEE 754 standard.
IEEE 754-2008

• Released in 2008
• Supports new types:
  • 16-bit floating point (*half precision*)
  • 128-bit floating point (*quad precision*)
REFERENCES

• Chapter 3.11 Historical Perspective and Further Reading
  • https://gab.wallawalla.edu/~curt.nelson/cptr380/textbook/history/section_3.11.pdf

• Wikipedia article on the Intel 8087
  • https://en.wikipedia.org/wiki/Intel_8087