Computer Arithmetic

Hüseyin Koçak
University of Miami

CSC 210
Faulty Arithmetic

```java
public class ArithmeticTest {
    public static void main(String[] args) {
        double x, y, z;

        x = 9.4;
        y = x - 9.0;
        z = y - 0.4;

        System.out.println("x = " + x);
        System.out.println("y = " + y);
        System.out.println("z = " + z);
    }
}

Output:
x = 9.4
y = 0.4000000000000036
z = 3.3306690738754696E-16
```
public class DoubleTest {
    public static void main(String[] args) {

        double firstProduct;
        double secondProduct;

        firstProduct = (9.4 * 0.2321) * 5.6;
        secondProduct = 9.4 * (0.2321 * 5.6);

        System.out.println("(9.4 * 0.2321) * 5.6 = \" + firstProduct);
        System.out.println("9.4 * (0.2321 * 5.6) = \" + secondProduct);
    }
}

Output:

(9.4 * 0.2321) * 5.6 = 12.217744
9.4 * (0.2321 * 5.6) = 12.217744000000001
public class IntegerTest {
    public static void main(String[] args) {
        int i = 1000000;
        System.out.println(i * i);
    }
}

Output:
-727379968
Boeing 787 software trouble

“We are adopting a new airworthiness directive (AD) for all The Boeing Company Model 787 airplanes. This AD requires a repetitive maintenance task for electrical power deactivation on Model 787 airplanes. This AD was prompted by the determination that a Model 787 airplane that has been powered continuously for 248 days can lose all alternating current (AC) electrical power due to the generator control units (GCUs) simultaneously going into failsafe mode. This condition is caused by a software counter internal to the GCUs that will overflow after 248 days of continuous power. We are issuing this AD to prevent loss of all AC electrical power, which could result in loss of control of the airplane.”

www.federalregister.gov

The error happens after $2^{31}$ centiseconds (248.55134814815 days), indicating a 32 bit signed integer.
Decimal to Binary to Decimal

http://courses.cs.vt.edu/~csonline/NumberSystems/Lessons/index.html
Number Systems
IEEE 754

IEEE-754 Standards for Floating Point
http://babbage.cs.qc.cuny.edu/IEEE-754/
Decimal to IEEE-754

http://www.ecs.umass.edu/ece/koren/arith/simulator/FPAdd/
floating point Add/Subtract